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MODELS AND THEIR GEOGRAPHICAL APPLICATIONS

Gábor Mezősi

There might be as many definitions of models as models themselves. In other words there are many. Hardisty et al (1993) wrote about it sarcasticly in their book, though for them there is but one model that can be precisely described by a mathematic equation or system of equations. It happens frequently that one cannot arrive at stating the relations in a purely quantitative form being necessarrily the best way to build a model. Therefore a survey of the different model-building schools and model conceptions can be useful. ***Models*** are mostly used today to ***describe, explain and analyze the operation of a system.*** They are often present in theoretical geography, helping to understand systems, as well as in applied geography where they are integrated parts of regional planning, environmental impact statement and predecision-making. The following three examples represent the various fields of model application.

1. Map (Figure 1)
2. Model-model by Chorley (Figure 2)
3. Simulation (Figure 3)

Both the ***graphic and the mathematical representation of reality*** can be considered as models. In general models can be referred to as ***special projections or idealized pictures of reality***. Every field of science can elaborate a model-definition of its own aspect. In case of a non-natural scientific approach, a model can be essentially a theory, law or a structuralized conception. In Chorley, R.J. - Hagget, P. (1967) and Kirkby, .J. et al (1987) there are several model-definitions; the former being considered as a principal work on geographical models and the latter a representative of the Leeds School.

System is a concept often mentioned with models. System and model are in fact very closely related to each other like property to its owner. What is more, a model always ***belong to a concrete system***, if the most general definition of the system is accepted, according to which it is a group of interrelated things. It is a question of aspect whether a landscape, a road network, a decision making management, a machine, a law or a map is a system or not. They ought to be considered or at least handled and analyzed as systems, however. There may be systems that are more difficult to scope with in society e.g. and they are still found to be real systems in recent research. There are, however, great differences between systems if their compounds and levels of hierarchy are considered. The concept of system is, however, an accepted and widely used category.

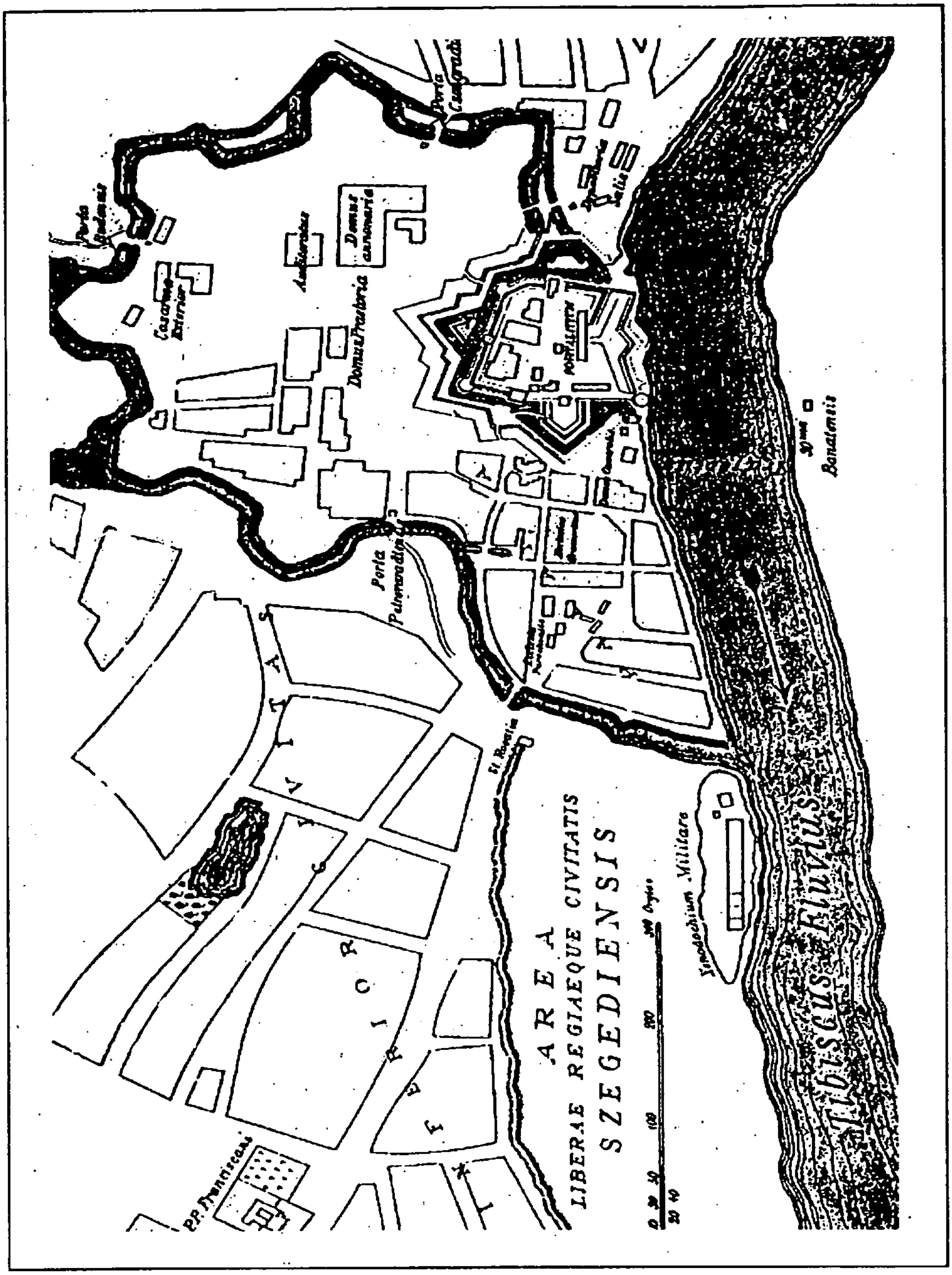

Figure 1. *Example No 1. The map as a model.* A map is a suitable model to represent reality and it is a theoretical model as well with all properties of generalization, which is suitable for the analization of the reality from different point of view

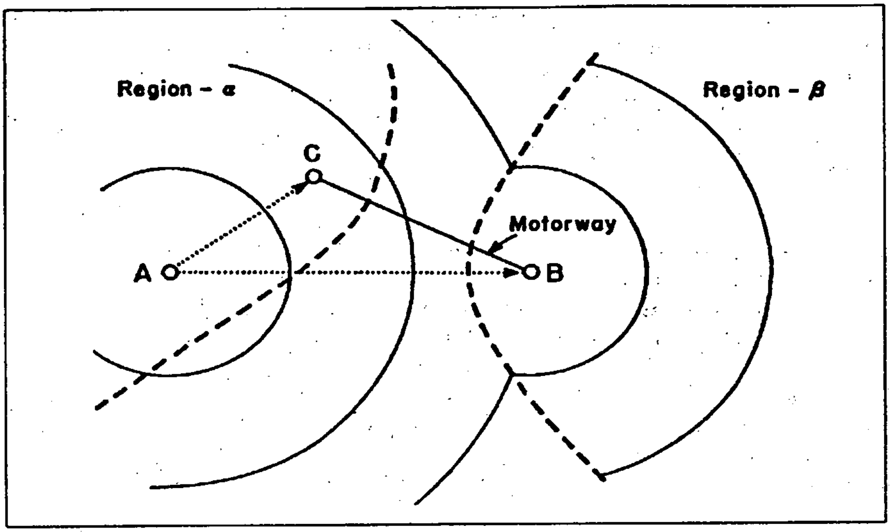

Figure 2. *Example No 2. The network model.* Within the ABC network, the shortest way is AB. If a motor way is built between B and C the road of the lowest cost will be ACB and the shape of regions a and b will be modified too.

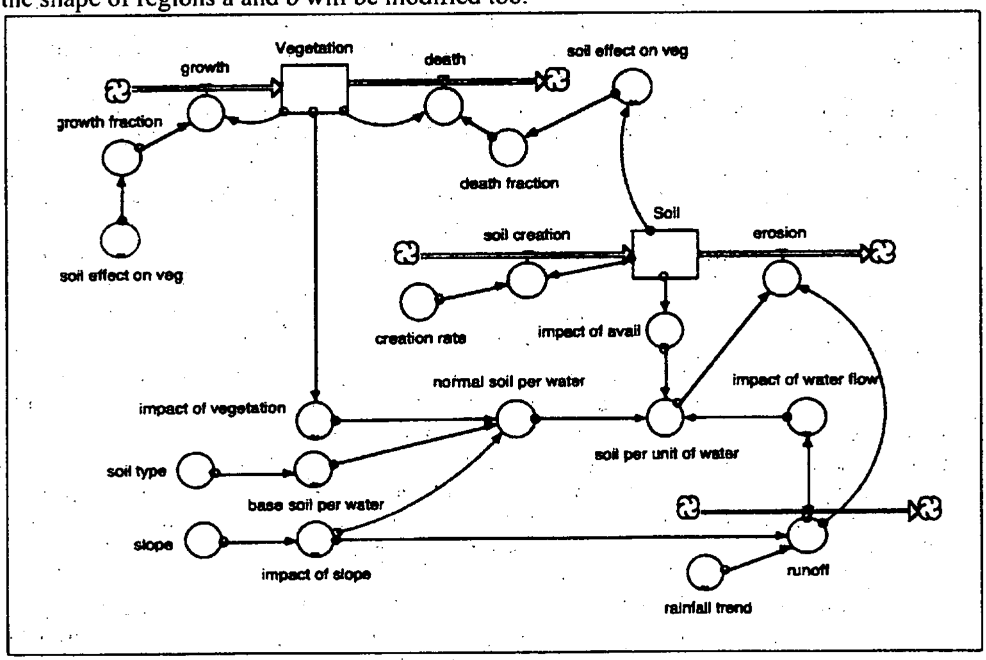

Figure 3. *Example No 3. A simulation network in the Stella II system.* The figure contains the different types of the variables with the run off scheme and the water budget of the soil.

Systems can be studied ***independently from their contents*** (see the general system theory of Bertalanffy), they have characteristic and ***common and specific features*** that show regularities and can be transferred from one to another.

When studying the relationship between models and systems, the phases of system-analyses by Hugget, R. (1980) ought to be mentioned. According to his finding in the system-analysis there are the following four phases built upon one another:

-- ***lexical phase***, when the boundaries, the contents (variables) the values of the constant variables etc of the system are tried to be understood.

-- ***describing phase***, when the relations between the variables of the system are tried to be defined in mathematically, physically or verbally.

-- ***modelling phase***, when the system is reconstructed and 'operated'.

-- ***analyzing phase***, when the validity of the model is analyzed.

The above does not mean,however, the model to be found only in the third and fourth phases. There are a lot of models helping comprehension in the lexical phase e.g. the schemes and patterns in text books can well be called models. The describing phase can often be left out, because its factors are difficult to be quantified. The steps of modelling can be put into a relevant order:

-- ***model building*** which uses the regulations of simplification, generalization and abstraction, taking the specific parametres of the model into consideration

-- ***model application*** which brings about new information through simulation devices e.g.

-- ***model assessment*** (the communicative part of modelling) which analyzes the validity of the model with its output results and examines different scenarios and alternatives.

From the above the advantages of the models can be seen in their geographical application. Models mean one of the easiest ways of professional *communication*, because the *information, theories and opinions* are displayed concentrated in them. When they are applied, problems of different nature can be compared, regularities can be adapted (Figure 4).

General characteristics of models

Aim and functions of model application. There are two large aim-groups considered in model applications. One of them contains the models used in practice (e.g. planning, prognoses, impact statements). They are used for calculations, prognoses, evaluations etc. The other group contains models helping comprehension. This frequently used grouppping is not precise enough, because the models used in practice and planning also help the comprehension of how the system works and because the so called models of comprehension sometimes do not have the full phases of model building owing to the troublesome quantifying (examples for this can be found in social geography, in the model representing the development of the financial sphere).

On the basis of the idea of Nijkamp, P (1978) the objective of modelling can be set as the *problem solving = aim + the structure of aims*. Nijkamp of course approaches this issue from regional planning, but in general and especially on the fields of social and environmental geography, there are several objectives to be realized together. This approach does belong to the natural sciences as well. Following this path the *functions* of

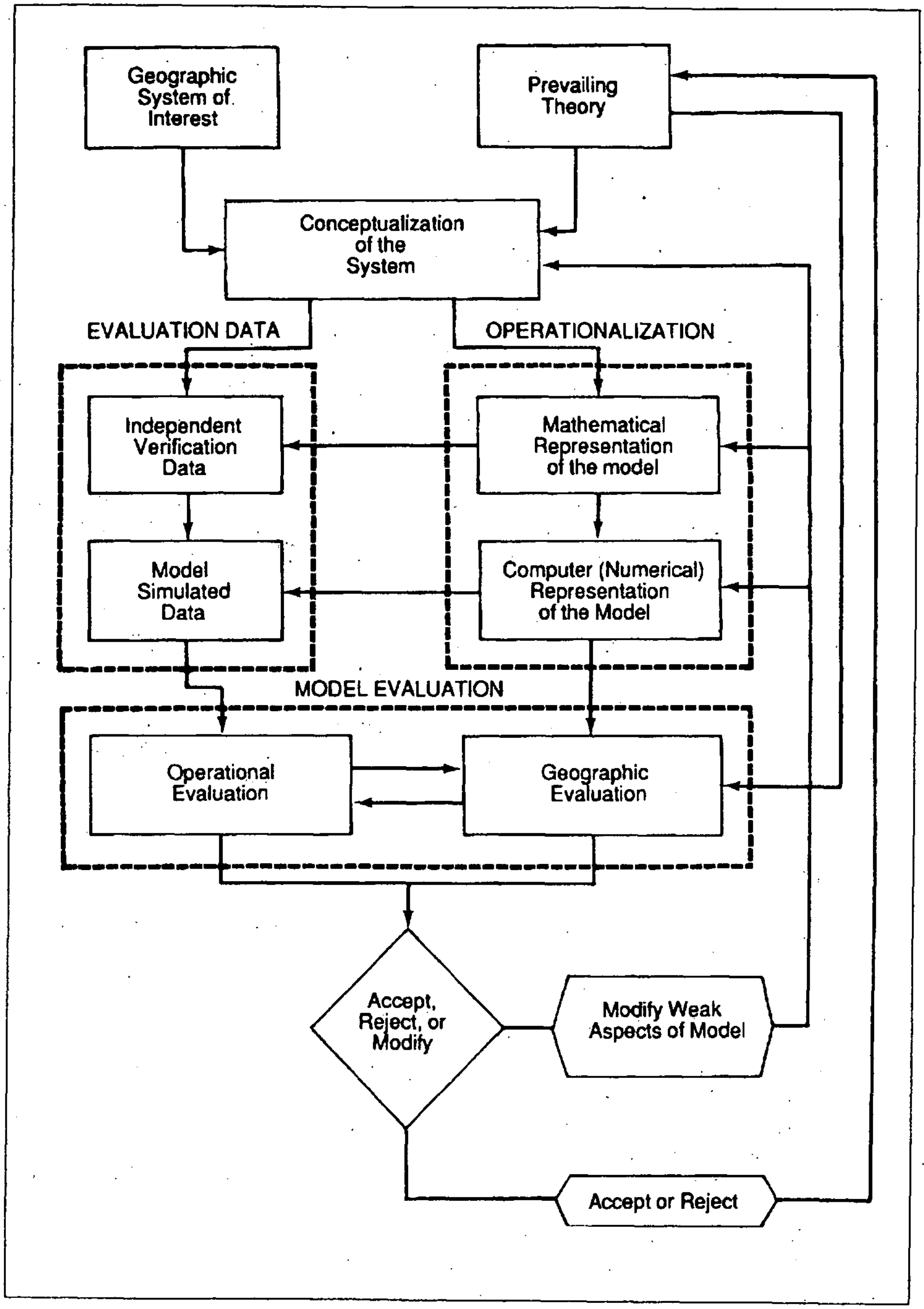

Figure 4. *Scheme of geographical modelling* (Abler et al 1992)

the models can be manifested easily, such as *revealing and displaying complex relationships*, shedding light onto the operation of the systems (e.g. through analyzing a process or an impact), or taking the simple ones: the collecting-categorizing function (because factors have to be listed) and the logical-psychological function (because relationships have to be interpreted and understood) etc.

One of the most complicated questions of models is probably the *relation between simplification and generalization (idealization)* and the *role of the scale* in connection with them. The success of model application is depending on the abstraction as it is put in every book on model building. There is, however, very little information on how to carry out this simplification. The map in Figure 5 helps to understand the relation between simplification and generalization. Both generalization and simplification cause information loss. If the scale is getting smaller from 1 : 10 000 to 1 : 100 000 e.g. there will be too much information to map and if it is getting the other way round, there will be too little information to map. In such cases generalization with the aggregated units should stick to the strip labelled with the row of dots when shifting from S1 to S2 and I2' is recommended instead of I2.

In the practice of modelling or (dynamic) simulation simplification is recommended to be performed first and then generalization (the so called 'upper way') according to Powersim (1993); those, choosing the 'lower way' should 'give up all hope' (see Figure 6).

The problem of simplification and generalization can manifest itself in quite different ways in different scales. With a global problem one cannot use a local model, like the global MIAMI Model cannot be applied to local, biological production schemes (NPP) to obtain a reliable result. In such cases the structure of the model is changing. The opinion formed in the 60s, according to which the models differ only in their style and they can be mutually transferred from one scientific field to another, is not true. Though transfer is an essential element of model application, it has got its limits to be observed.

Characteristics of models

The characteristics of models are summed up by Chorley, R.J. and Hagget, P. (1967) as follows:

-- they should be approximative i.e. simple enough to aid users, to help intelligibility, but it should not result in a loss of complexity;

-- they should be suggestive i.e. a sphere ought to be ouylined in which they are relevant. (This is especially important in geography because of the scale.) Their ability for prediction should also be stated etc.

-- They should be selective i.e. they should contain only the 'important' factors through elimination where necessary.

-- They should be structurized to reflect both the taxonomic and the relational structure of the system.

-- They differ from reality exept for analogy.

-- Models should be applicable for the above mentioned objectives and this is their most debated feature.

Types of models

The grouping of model types are presented to show how versatile they are. According to the categories drawn by Chorley, R (1967) they can be:

1 Systems based on analogy:
  a/ historic analogy ('present is a key to past' as applied by Lyell in geology and landscape evolution and by the chronology of denudation;
  b/ spatial analogy (this category has been worth being criticized, because the theory of global warming up by Budiko e.g. can be applied to future only in a very limited extent).
2 Physical models:
  a/ hardware models (they are mainly made or built from some natural material, but in a wider sense, the modelling of soil erosion also belongs here e.g.);
  b/ mathematical models. They can be determined (like linear equation systems and differential equations) and stochastic (like statistical devices).
3 General systems (they are mostly theoretical models bearing the problems of resolution and detailednedd as it has been mentioned earlier):
  a/ synthetic models are mainly homomorphic containing only a few elements (white box -- where all relations and processes are known);
  b/ partial models (grey box -- where the relations between the factors van be expressed in terms pf mathematics, but the processes cannot);
  c/ black box models (where only the input and output information is known like in the isomorphic models containing every element).

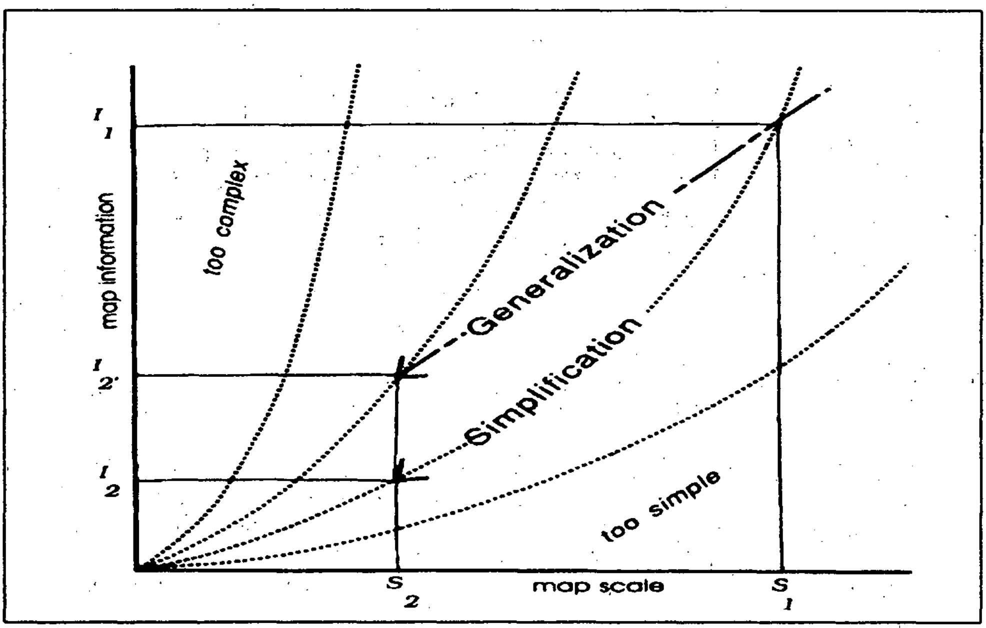

Figure 5. *The relation between simplification and generalization in cartographic model application (Abler et al 1992)*

Another approach is that of the descriptive models (aimed to put emphasis on the balance and process in the static and dynamic subtypes) and the normative ones (spatial or predictive). They are categorized by Güssefeldt, J. (1979) as follow:

model			
Layout	**physical entity**	**relations**	**way of expression**
iconic	'paper'	descriptive	determined
analogous	'hardware'	normative	likelihood type
symbolic	'software'	hypothetic	stochastic

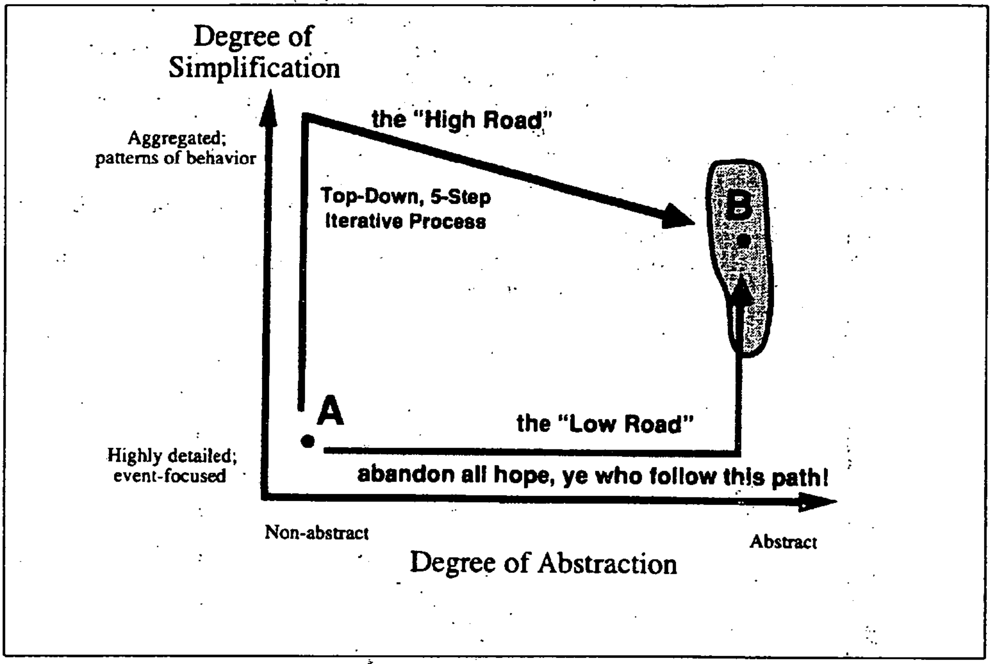

Figure 6. *The relation between simplification and generalization in simulating model application (Powersim 1993)*

This classification does reflect the chaos regarding models in the geography of the 80s. The critics of this classification like Köck, H. e.g. among others, had reasons that can hardly be accepted today. E.g. if models are representing things, they should be classified on the basis of their representational or non-representational contents.

When approaching model categorizing from the viewpoint of planning, it is a geographical classification as seen with Nijkamp, P. (1978, Figure 7).

For those, fond of definitions, let us define what models are: they are the representation of reality with simplified structure, showing relations thought to be important in a generalized form.

Geographical models?

In our opinion geographical models can be specificonly as far as their **topics** or perhaps aspects are concerned. Transferability is an essential feature of model application, securing their thematic independence. One might remember the polarized definition saying: the model is the 'picture' of the system which exists only virtually. The quality of this 'picture' depends on the available and obtained knowledge about its system.

There are some aspects giving specific features to geographical models, however. One such feature may be the *scale* related to the Greek idea of models. In geography it is especially important how a micro level construction can be tranferred into meso or macro levels. Another feature may be the model's evaluation that is a specific geographical feedback.

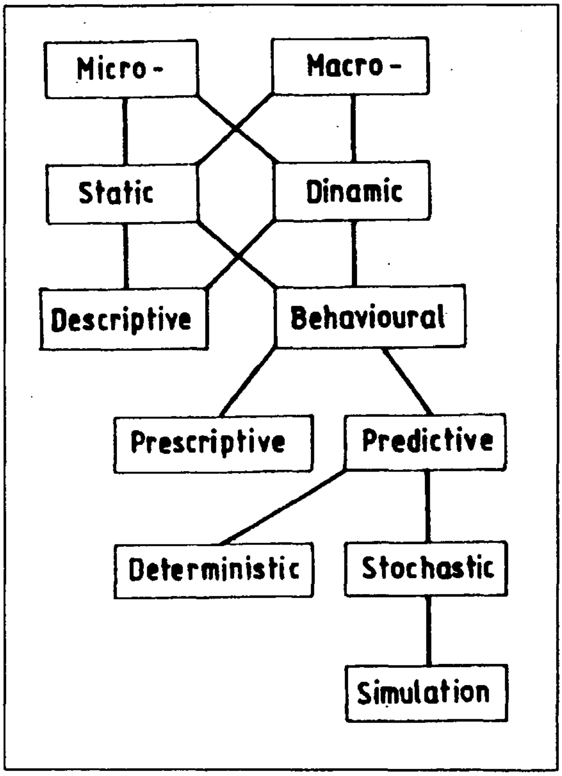

Figure 7. *Model types and their relations (Nijkamp 1978)*

References

CHORLEY, R.J. - HAGGETT, P. 1967. Models in geography. Methuen, London p. 816.
HARDISTY, J. et al. 1993. Computerized Environmental Modelling. Wiley, Chischester p. 204.
HUGGETT, R. 1980. System analysis in Geography. Calderon Press, Oxford p. 210.
KIRKBY, M.L. et al. 1987. Computer simulation in Physical geography. Wiley, Chischester p. 227.
NIJKAMP, P. 1978 The system view of planning, Pergamon Press Ltd. Oxford, p. 431.
POWERSIM 1993 Reference Guide Ver. 1.1, Bergen p. 278.
GÜßEFELDT, J. 1979. Die Bedeutung von Modellen in Forschung und Lehre der Geographie. GR. 1979.31.8. pp. 323-331.

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LANDSCAPE CHANGES IN THE TISZA RIVER VALLEY FROM THE 'TURKISH RULE' TO THE 20th CENTURY

László Gruber - Róbert Géczi

Introduction

The Tisza River valley has changed a lot for the last one and a half century. When Count Széchenyi launched the regulation works on the Tisza at Tiszadob in 1846, it marked a new era of the river. This process exercised a major influance on the plainland. Vast moorlands, swamps, a lot of ox-bow lakes, immense floodplain had defined the landscape of the Tisza region up to the middle of the 19th century. The bends on end hardened floods passing by. Floods followed floods making it difficult for man to live in the region. The wetland was inhabited by fishermen, hunters and marsh-dwellers. There were water mills, further slowing down the river's and its tributaries' flow. The decreasing floodplain forests and the scattered settlements contributed to the versatile landscape features.

Vast regions were permanently or periodically flooded on the territory belonging to Csongrád County today too. The section of the Tisza between the mouths of the Körös and the Maros could hardly be recognized, had it been seen as it used to.
What were the physical and human impacts effecting the landscape and how did the changes influance man's dwellings and land use?

Maps and surveys

Let us make a list of the available maps and survey-records on the above topic. The first maps having hydrogeographically important details too were issued at the end of the 18th century under the reign of Emperor Joseph II. This 'enlightened' ruler was the first to order the military survey of the country and most of Hungary was thus mapped in 1782-85. This mapping conducted by Colonel Neu opened a new era in Hungarian cartography. The scale of the survey was 1 : 28 800. The maps served military purposes first of all. It is especially reflected in the description (Landesbeschreibung) attached to each map.

This map-collection, called 'Josefinische Aufnahme', was elaborated with pattern of stripes. Elevation values were not indicated on the maps, but the rivers, brooks, lakes, swamps, forests, orchards, vineyards and roads are accurately represented, compared to the mapping devices of the age. When viewing these maps, the high and the low floodplains can be seperated fairly well. Alkali fields can be recognized (like at Badidai, Lalei, Keskeny and Tisza Szik) and the morphology, structure and extention of the settlements are also manifested. The survey collected data on the former river beds and the destroyed and abandoned settlements too (like 'gewesenes Dorf Sablia'). Isolated farmhouses on the outskirts of settlements are named 'Tanya' and small groups of houses far away from settlements are named 'Szállás' in the maps. Their full names are derived the destroyed and abandoned settlements too (like 'gewesenes Dorf Sablia'). Isolated farmhouses on the outskirts of settlements are named 'Tanya' and small groups of houses far away from settlements are named 'Szállás' in the maps. Their full names are derived from their owners at that time (Kinyecz Szállás, Jeney Szállás etc). Locations where there were no settlements found at all, were named 'Puszta' in the maps (e.g. Győry Puszta, György Puszta, Karai Puszta, Királyság Puszta, Szénás Puszta, Szőlős Puszta).

The strategical objectives of the survey are also reflected in the accurate locating of the bridges, fords and even the sites of the scaffolds (Hochgericht), e.g. there was a place of execution between Szeged and Dorosma.

The 'Land Description' contains the most important data of the waters, forests, hills, roads and buildings shown in the map. The distance between the settlements is given in hours.

The maps of this *first military land survey* used to be top secret and they were accessible only for the royal court.

Joseph II also ordered a land survey to classify croplands according to land use and yield. It ought to have helped levying tax on agricultural activity. Consequently, first of all the land owning aristocracy objected it, The emperor withdrew this order (with many others) before he died. Though the land survey had been carried out in a part of the country, after its withdrawal the maps and documents were destroyed. It was done so perfectly that not a single document or map did survive from that project. The following cadastral land survey took place 80 years later (it was ordered in 1870 only).

The *second military land survey* is known as 'Franziszishe Aufnahme'. The scale of the map collection was 1 : 28 800 also. The maps of the Hungarian territories were prepared from 1829 on. The plainland counties were mapped in the 1860s. Csongrád County was mapped in 1860-61 and Békés County in 1863-64.

Unlike the first military survey, the land description pages were missing with the second one, but the maps themselves were much more exact and their layout more perfect than in the first one. The contour lines were still missing in these maps, but the morphological details are more developed than in the maps of the first survey. When comparing the maps of the two surveys, the development of the road and the settlement networks can well be seen, along with the landuse changes ensued since the 18th century. The names of the regions, sites, fields were also written on these maps, making them especially valuable.

The 1: 25 000 scale maps of the *third military land survey* were contructed mainly in 1883-84. The well detailed maps outline the landscape changes compared to the previous ones (Figure 1).

There were hydrogeographical maps prepared in the 18th century as well and they were examined too in our research. The surveys concentrated on the strategical interests too. The court found the floodplains too vast, yielding no income at all. (It was the main reason for which Joseph II had ordered the cadastral land survey that failed.)

There were maps of the Tisza drawn in the first half of the 18th century showing certain sections of the river only. The 1 : 38 400 scale map of the Tisza section between Tápé and Szalándkéménd compiled by Ernst Helchis in 1739 was one of them.

The map series entitled *'Praeliminaire Flusskarte'* made under the reign of Joseph II is of special interest for today's research. These maps represent the Tisza sections in a shire or county. Hydraulicians used Müller's map from 1709, because the military maps were secret, and this Tisza map was fairly reliable. During this survey the country was divided into 10 water regions. This survey was brought about by the ever increasing economic role of inexpensive river transport. The Tisza and the Maros rivers were mapped by order of the court (Joseph II), because these two rivers played a leading role in transporting salt from the Transylvanian mines.

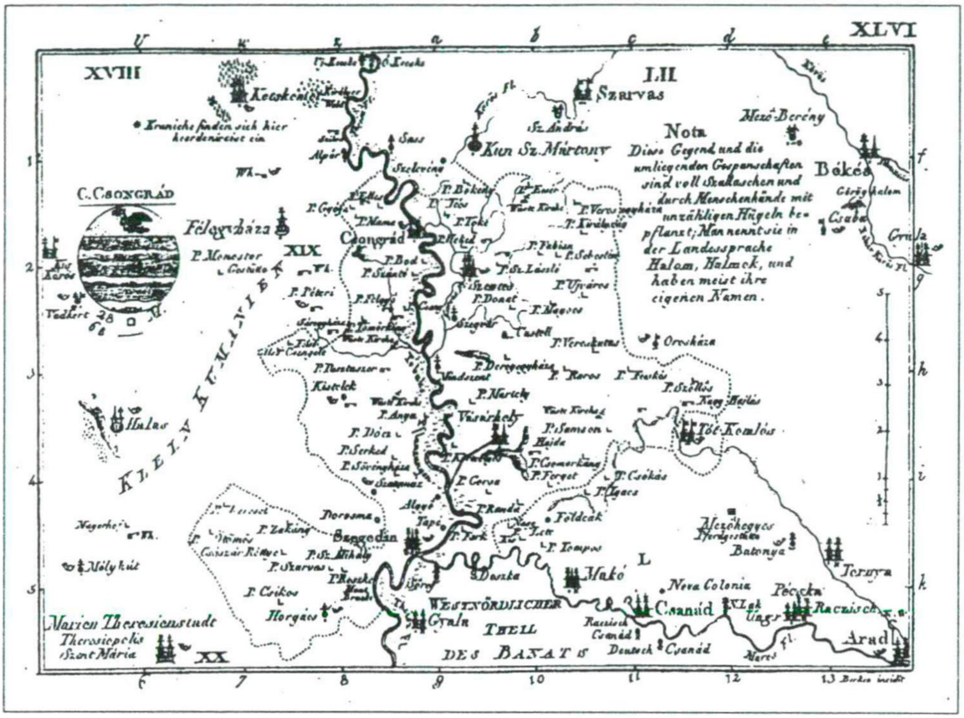

Figure 1. *The Tisza in Csongrád County (source: the Korabinszky map collection, 1805)*

Antal Balla's Tisza map from the mouth of the Sajó River down to Csongrád, János Budinszky's map of the Tisza in Ung County and Spatzek's Tisza Map from the mouth of the maros River down to Titel were made by such a court order in the scale 1 : 86 400.

József vertics mapped the Tisza section between Csongrád and the Maros Mouth. His work became known as *'Theis Fluss in Csongrader Comitat'*. I does not belong to the above mentioned 'Praeliminaire' fluvial maps, though its scale is the same and it was probably made on court order too.

The 'Korabinsky map collection' issued in 1805 should also be mentioned here. It represents the hydrogeographical conditions at the turn of the century (Figure 2).

The above mentioned maps from the end of the 18th and from the beginning of the 19th centuries are especially important data, because they reflet the hydrogeographical conditions of the Hungarian Plainland prior to the water regulation works on the Tisza River.

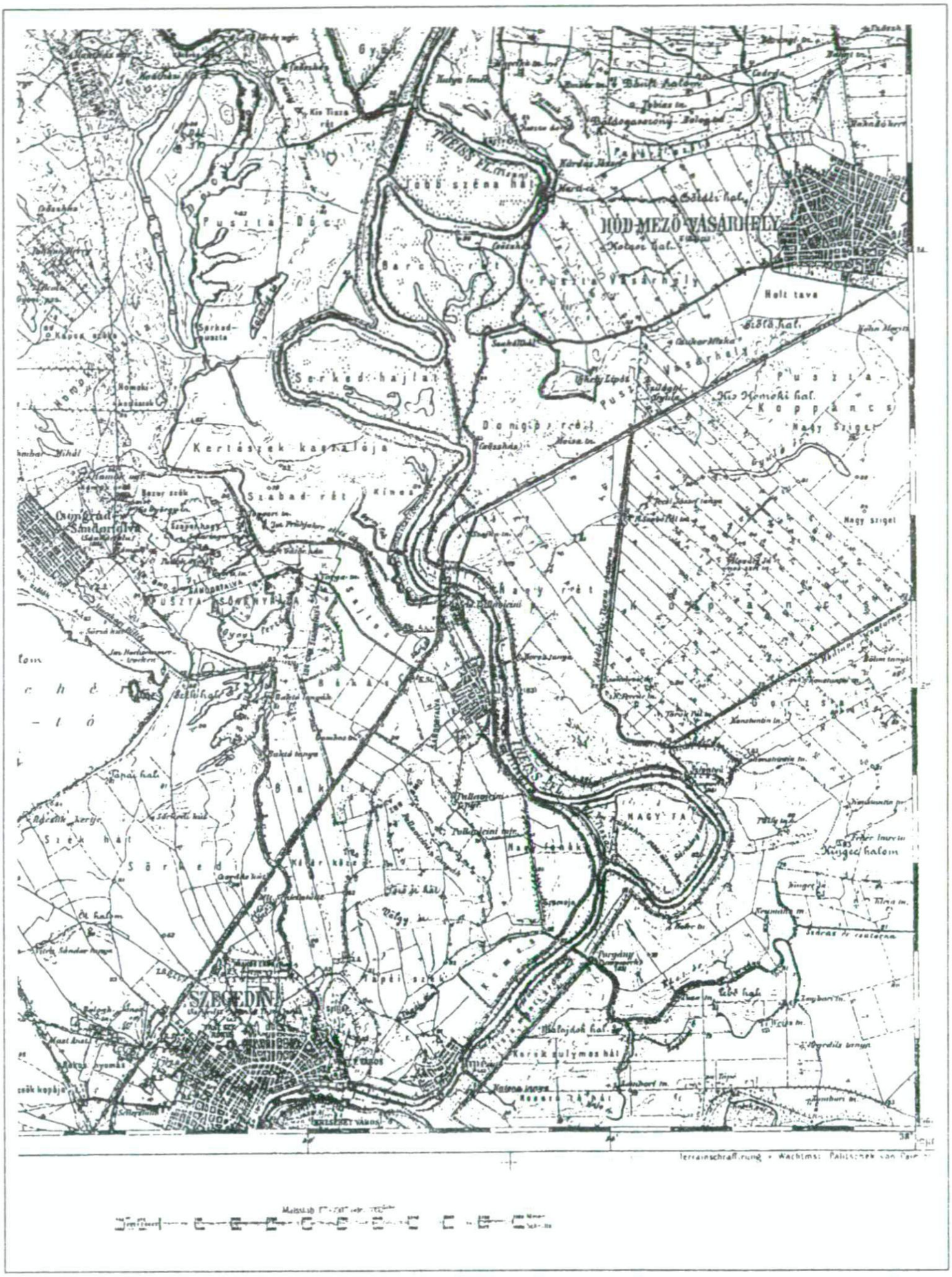

Figure 2. *The Csongrád County section of the Tisza River at the end of the 19th century (source: the third military survey)*

Summary of landscape evolution from the 'Turkish Rule' to the 20th century

Let us examine the changes of the value of the surface from the 17th to the 20th century. These changes can be listed in two categories: the dominant physical changes and the landscape changes ensuing on human impacts either direct or indirect.

Cultural-geographical periods of landscape can be defined on the basis of *man-environment interdependence and relation*. In this relationship human culture ha a double role: partly it is *accomodating* to its environment and partly is *changing* it.

Water has always been prominent among the geofactors of the plainland, especially in the Tisza River Valley. Therefore a special attention should be paid to the relation of the old water pattern and human culture in this region. Flowing and stagnant waters both exercised significant impacts on economic activity, land use, restructurizing of settlement networks, the methods and materials of building.

The Hungarian Plain can be divided into two large mosaic-patterned regions from hydrogeographical viewpoint: the areas of the so called 'rétség' (floodplain meadows) and the 'mezőség' (floodfree fields), the latter having been the scene of crop cultivation. The 'mezőség' areas represent the 'bread baskets' of the Hungarian Plain.

53 % of the flooded areas in Hungary used to be situated along the Tisza and its tributaries. Frequent or permanent flooding used to be characteristic of the low floodplains, while periodical floods occurred on the high floodplains. These areas determined the 'levels' of traditional live-stock farming.

The first settlements were formed on the boundaries of the floodplains and the floodfree lands. They were the ancient centres from which crop cultivation radiated out. This border region is called *'ancient settlement line'* by Frisnyák, S.

Let us have a brief summary of the changes in man-landscape connection from the 'Turkish Rule' to the 20th century.

Human activity during feudalism, following the local human environmental impacts of the Árpádian Age (such as digging canals and building earthworks) showed something that might well be called a dynamic harmony between man's adjustment to nature and his environmental impact. Though its reasons were rather objective than subjective (think of the stages and main trends of technical development in human history).

In the end of the 15th century the Southern Hungarian Plain belonged to the most developed regions of the country. The largest break in the development of this region was marked by the Turkish invasion and the ensuing *Turkish rule* over this territory that lasted for one and a half century. During the Turkish age the so far existing *cultural landscape* went through a complete *degradation*. The general decline of economy had its impact on the landscape of the Plain too.

What were the major tendencies describing the physical state of this region during the 16th and 17th centuries?

First the ever increasing *forest clearing* has to be mentioned. Wood was needed a lot for building forts, and mainly for making potash and charcoal as these products belonged to the most important taxable items. Wood in the hilly regions was used for mine-timbers and for fuel in metallurgy.

The extended deforestation of course had its impact on the landscape. As a consequence the sand movement were reoccurring and both the levels and the passing time of the floods changed. Flood waves were speeding up and they reached the plainland erosion-base in a short time with a steep profile. According to the findings of Jakucs, L. (1982) a 10 % deforestation increase in the hilly region cause a 5 % increase in the rivers' runoff coefficient.

The destruction of the plainland woodstock resulted in an increasing 'pusta' (barren grassy plain) character of the Hungarian Plain during the 16th-17th centuries.

Another emerging feature was the *increase of the swamps and wetland.* It had several reasons: The risen flood level caused by deforestation overflew territories that had been floodfree earlier. The Tisza and its surroundings changed into a vast wetland. This moorland became a paradise for fishermen, hunters and marsh-dwellers. Persecuted inhabitants of attacked settlements often found shelter on the islands of the moorland. The floodplain was enlarged artificially too, due to self-defence of the local population. Fortresses and fortified settlements were encircled by canals to bring water and form a swampy area around. It happened to Szeged too.

Turkish rule and the constant wars contributed to uncertainty of existence which led to *depopulation* and desolation of the cultivated land. The pusta and the 'bozót' (shrubby areas) gained place. Rural settlements partly moved to areas of higher elevation, partly 'hid' in the marshland.

Summing it up: the prosperous economy and society of the Southern Plainland of the end of the 15th century declined in the 16th and 17th centuries into a peripherical condition.

During the 17th and 18th centuries man's activity effecting his environment exceeded his capability of adapting to it. Besides the above mentioned human impacts the emergence and change of the economic factor gained importance. It was manifested in transportation.

After driving out the Turks, there was much land and little labour power available in the Plainland. The lack of implements and labour led to a spontaneous immigration first, then to an organized one under the reign of Empress Maria Theresia. Thus the population of the Hungarian Plain increased from 125.000 (meaning 0-10 population density per sq km) in 1720 to 950.000 in 1787.

After the dislodgement of the conquerors, the relative abundance of land resulted in the primitive first-broken form cultivation instead of the more developed three-course rotation. It was a step back in land use. In spite of this, the ratio of croplands was rising along with the population number throughout the 18th century. Crop cultivation was slowly growing in the loess-pustas, in the areas covered with chernozem soil, in the snady regions with brown forest soil and in general, in the floodfree areas. It was completed by a sort of nomadic stock-raising, mainly on the amphibic levels of floodplains.

A new wave of deforestation began in the 18th century. It led to the almost complete loss of the plainland forests. Only a few gallery forests and groves remained along the Tisza. The greatest extent of treelessness and pusta character described the Plainland during the 18th century (Somogyi, S. 1994). An unavoidable result of the further deforestation was the further increase of flood risk. The frequent danger of flooding urged the regulation of the plainland streams and the Tisza first all. A few land owning, local aristocrats were backing the idea too. Because of the insufficient means and possibilities of transportation, the locally produced grain had to be processed on spot.

A long sequence of water-mills were built on the Tisza and on its affluants. The mill-dams impounded water, flooding and swamping new areas. It was often the subject matter of law cases.

From the second half of the 18th century a certain reconstruction of the cultivated landscape could be observed. On the floodfree levels the three-course rotational cultivation became dominant again.

The cropland-communites' land use began to disappear and the authorized land-ownership brought about the spreading of the isolated farmsteads. (At first these isolated farmhouses functioned as winter shelters and the complex farmsteads appeared only in the 19th century.)

Traditional land use in the floodplains remained characteristic and orcharding, horticulture and viticulture developed around the major settlements.

Wind-blown sand was started to be stabilized by afforestation, land reclaimation works were also started in swampy marshland areas and rivr regularization was begun.

This change in land use had its feedback on settlement structure. With the occurrance of private land property, the settlement form characterized with central lying double-grounds began to disappear. Residential buildings were erected in the sty-gardens formerly encircling the settlement core. Croplands gained place in the pustas used for grazing stock so far. Only the zigzagged street network related to the former double-ground structure. Such rural settlement do differ from the chess-board patterned newcomers' settlements in the Southern Plainland.

By the beginning of the 19th century, there was a prosperity on the cereal market due to the Napoleonic wars. It resulted in the further spreading of the croplands at the cost of grazing fileds. Thus crop cultivation was soon blocked by the vast floodplains. At the same time the growing flood risk resulting from deforestation, endangered more than 800 settlements that used to be only a few metres above flood level so far. The growth of the croplands and the population of the floodfree areas and the repeated floodings all cried for a general river regulation project. Both economic and hydrogeographical factors contributed thus to launch an integrated environment-changing activity in the region.

Sámuel Lányi was engaged in the survey of the Tisza River Valley in 1834-46. Count Széchenyi published two articles on the above matter (1830, 1846). Széchenyi, the 'greatest Hungarian' put emphasis on the active water management that included the projects of not only the regulation, but those of irregation, canalization, river transportation and afforestation.

The construction affecting environment was enlarged from 1846 on. The works concentrated on the river regulation of the Tisza Valley in 1848-1918.

Pál Vásárhelyi and Péter Paleocapa both made a comprehensive plan of the Tisza regulation project. While Vásárhelyi preferred cutting off bends and dams built close to the river, Paleopaca proposed less cut offs and wider floodplains between dams. The compromise included many cut offs and wide interdam stripes. So the total length of the Tisza was decreased from 1419 km to 962 km. A canal system of 1200 km, and the dam system of 4500 km accompanies the river today.

The river regulation works started in Csongrád County in 1856. 11 bend cut offs were made and it resulted 58 km loss in the river's length within the county. (Today it is 108 km in Csongrád County, see Figure 3.)

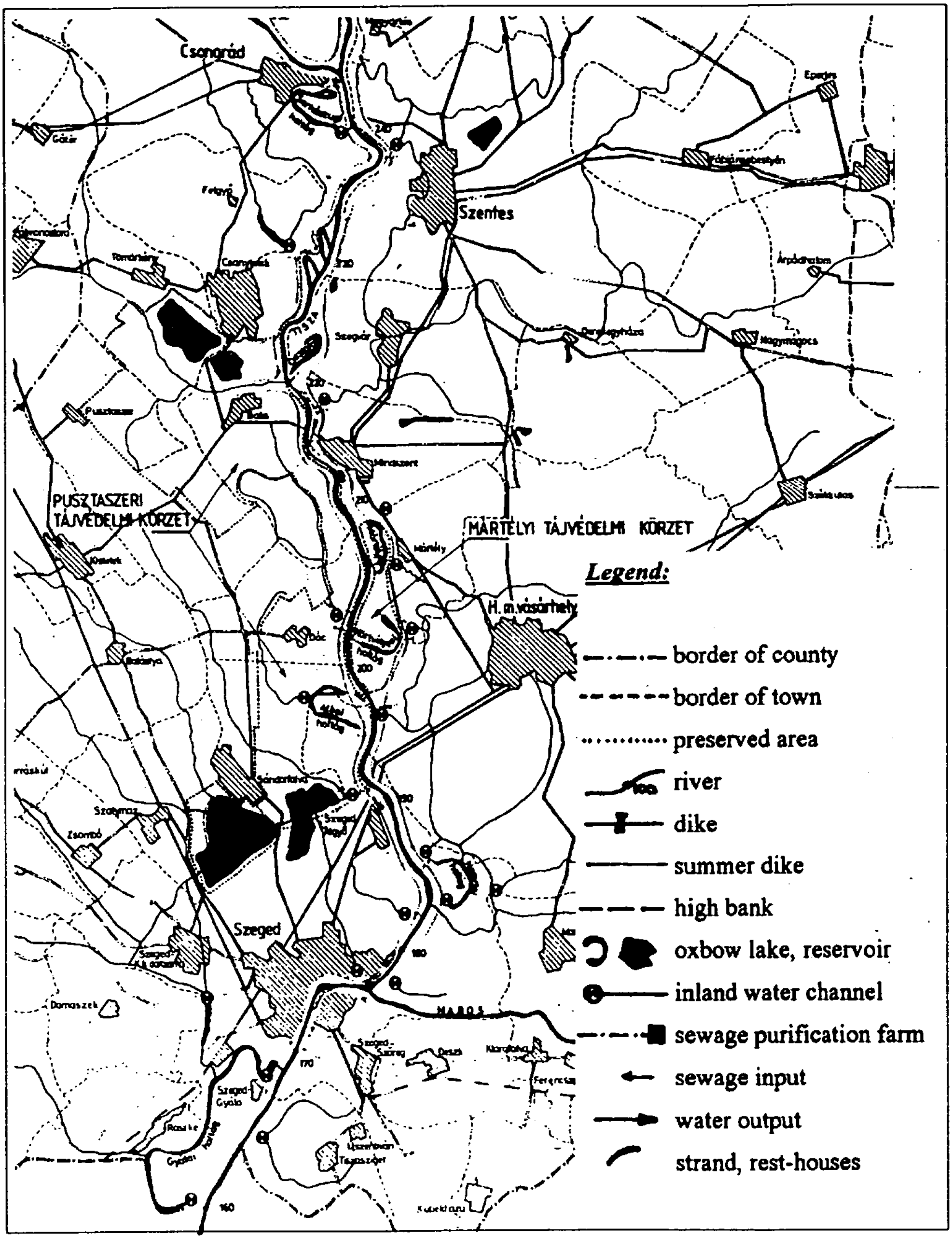

Figure 3. *The Csongrád County section of the Tisza River in the 20th century (source: Atikövizig, 1990)*

Regulation and water management works strongly affected the productive structure, ecological and living conditions and microclimate. Regulation caused a faster flood wave passing, accompanied with high and low water levels. The dropping level of low-water hardened shipping on the river.

An intensive accumulation in the foreshores also began. The floodplain of 2.48 million hectare was replaced by a total 100-120.000 hectare foreshore (Somogyi, S. 1994) and the river's float was deposited there. Thus the mineralogenic sedimentation and the streamwater supply of the mortlakes outside the dams were stopped.

The shrinking water surface made the groundwater level drop and it played a leading role in steppe formation and related soil transformation. The former floodplain groves, reedbeds, swamps dried out and a new soil formation was started. Marsh and swamp soils turned into meadow chernozem and alkali soils were developing in the former, salty floodplains.

With the water regulation works the *double face of the Hungarian Plain disappeared*: a uniform floodfree surface was formed in the previous floodfree and periodically flooded areas. This homogenous surface was dominated by crop rotation cultivation. Besides, both stabling and grazing livestock became characteristic of the region.

Several wetland plant and animal species became extinct and the fish stock was also reduced.

Local climate did also change: the shrinking water surface caused a lessened evapotranspiration, and the dried out surface became a subject to new forms of eluvial erosion.

The dropping groundwater level and the protecting dams made both the former high and low floodplains be part of the cultivated steppe. The willow, poplar and the reed survived only at spots of higher groundwater table. Croplands, orchards and settlements took the place of the cleared high floodplain woods. Mainly wheat, maize, potato and other industrial plants were grown in the croplands.

The dropping groundwater, the land cultivation and animal keeping emerging into the former pusta-meadows made the vegetation cover change at least partially on the loessy levels of the floodfree plains.

The sandy washes were stabilized with acacia and black pine. The remains of the sandy pusta-meadow could be found in small patches only. Where sand was stabilized, orchards and grape plantations thrived (the plainland viticulture gained special importance during the great phylloxera of the 1880s).

Water regulation works influenced infrastructural development as well, because road and rail networks could freely be built. All this and the above mentioned facts exercised an impact on settlements. More and more villages and farmsteads were built on the former floodplain. Building materials also changed: tile replaced thatched roofs, brick and adobe replaced mud-covered wooden walls.

Sanitary conditions improved; less typhoid, dysentery cases were reported and the ratio of infant mortality decreased. All this resulted in an increasing natural growth of the population.

One thing has to be noted, however. Series of humid and arid years alternate each other. Water regulation works so far has concentrated on the problems occurring during the humid periods, while irrigation, canalization and river transportation have not been paid enough attektion to. Their disadvantageous effects can still be felt today.

When the environmental human impacts of the 19th century is being summarized in a sentence, the regulation works can be regarded as a tool to dynamize the Plainland macroregion, leading it out from its four century long peripherical situation.

Selected bibliography

CSENDES L. (1980): Map history. Magvető Kiadó, Bp. 212 p.

CSENDES L. - N. IPOLY M. (1977): Maps of settlements from the first, second and third military surveys. Hadtörténelmi Térképtár, Bp.

EPERJESSY K. (1928): Manuscript maps of Hungary from Vienna. pp 12-45.

FODOR F. (1955): Hydrogeographic mapping of Hungary in the age of Joseph II. Vízügyi Közlemények 3-4. pp. 379-396.

FRISNYÁK S. (1990): Hungary's historic geography. Tankönyvkiadó, Bp. pp. 37-156.

FRISNYÁK S. (1995): Culrural-geographical eras of the Hungarian Plain. In: Frisnyák S.: Tájak és tevékenységi formák. Földrajzi Tanulmányok, Miskolc-Nyíregyháza. Észak- és Kelet-Magyarországi Földrajzi Évkönyv. Szerk.: Boros L.

JAKUCS L. (1982): Reasons and factors of flood frequency in the Tisza Catchment. Földrajzi Közlemények 3. pp. 212-235.

LÁSZLÓFFY W. 55(1982): River Tisza: regulation and water management. Akadémiai Kiadó, Bp. pp. 13-423.

SOMOGYI S. (1967): Geographical research into water regulation and flood evading. Földrajzi Közlemények pp. 145-158.

SOMOGYI S. (1980): Former and recent social effects on Hungarian rivers Alföldi Tanulmányok IV. Békéscsaba pp. 19-36.

SOMOGYI S. (1994): Changes of the geographical landscape of the Hungarian Plain. Történeti Földrajzi Tanulmányok, szerk.: Frisnyák S., Nyíregyháza, 25 p.

SZÉCHENYI I. (1846): Ideas regarding the regulation of the Tisza River Valley Pesten, p.73.

Protection and usage of the Csongrád section of the . Alsó-Tisza vidéki Környezetvédelmi és Vízügyi Igazgatóság, 1990. 32 p.

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ACTA Geographica Szegediensis Tomus XXXV. 1994-95. pp. 21-43.

THE FUTURE ECOLOGICAL VALUE OF THE HUNGARIAN LANDSCAPE

Gábor Mezősi - Ilona Bárány-Kevei and Róbert Géczi

Introduction

From an economic aspect, landscapes have different, direct and indirect values, or according to Naveh (1984), hard and soft values. Most of the hard values can be measured well, e.g. the values of the direct economic benefit, such as the NPP or the ecological value used in landscape ecology (Marks et al. 1989). From economic considerations, some authors rank the use value of landscapes into this category, though it cannot be measured directly. However, there are certain real, measurable data to rely on (Rodge 1990). For instance, people spend a considerable sums to visit national parks; or the value quitness can be expressed when the prices of two flats of otherwise similar quality are compared, with one of them situated in a noisy street and the other in a quiet one. The indirect values of landscapes, such as recreational value, nature conservation value and aesthetic value, are usually poorly defined: they contain many subjective elements, which are difficult to measure. This limitation must be considered in the planning and managing of landscapes.

In this study, currently available information is used to analyse the probable changes in ecological value of one of the most characteristic landscapes in the Carpathian Basin, the Danube - Tisza Interfluve, in the next 50 years. A dark future is often predicted for the Danube - Tisza landscape, due to direct and indirect human effects, the growing aridity, the falling groundwater level and the impoverization of the local population.

The Danube - Tisza Interfluve is a plain interspersed with numerous orchards and vineyards, covered with blown sand. Its central part, accounting about 60%, has semi-cohesive and cohesive blown sand and anchored dunes, embracing flat interdune basins with a high groundwater table. It is covered by a patchwork of sandy pusta or acacia - poplar vegetation. Its NE and SW parts are loessy plains covered by chernozem soil with a deep-lying groundwater level. It is a cultivated steppe. The W. part is an elevated flood plain with meadow soil.

Method

The analysis involves an assessment of the changing value of the future landscape through modification of the ecological value. The ecological value is a category used in geography; it is not strictly defined, and thus it can be approached in various ways. It can mean the condition of the ecotopes, the productivity of the landscape or the utility factor of the landscape. In the course of the analysis, an attempt was made to calculate the change in the ecological value from all three aspects, which therefore fulfilled a controlling role for one another.

The essence of the applied method is the estimation of the consequences due to the ecological values of the 20 and 50 - year climatic and water turnover data sequences in the Carpathian Basin and the Danube - Tisza Interfluve as the test area. This approach, however, has number of weak points. The exactness and errors of a long-range ecological prognosis are difficult to assess. The dynamics of the changes predicted in the landscape building factors may differ greatly and the changes can occur in different directions or at different levels (e.g. the transformation of a forest association may take 80 to 100 years, while that of a grassland takes some 10 years).

The condition of the ecotopes was defined in accordance with a German proposal (by Marks et al. 1989) on the basis of the maturity, naturality and diversity of the vegetation. The scores for each of the factors were added and averaged for large areal units of the landscape. The investigation of different ecological demands (T - temperature, W - water supply, R - soil reaction) of the vegetation has had considerable traditions in Hungary since the mid 1960s (Soó 1964). Long-term data are available on the pusta vegetation in this form. This structure is mostly harmonized with the above mentioned, quantified German system.

In the second approach an effort was made to calculate the regional differences in the NPP value by using the Thortwhaite Model (in Leith 1974).

The ecological value shift was finally supplemented by an analysis of the land use albedo system in order to detect the positive or negative direction of the landscape utility caused by the forced changes in land use.

Initial data

The climatic changes induced by thehuman impact in the past 100 years are explained by experts in different ways (some have even expressed doubt that there has beeen such a change), but most of them agree that measurable changes have taken place in an accepted trend. They also concede that the global changes can be modified to various degrees at the local level. Later, therefore, we consider only the climatic data sequences in the Carpathian Basin. There are several groups of sequences (as in Mika 1993, Szász 1993 and Varga-Haszonits 1993). The predicted changes are similar as regards the two most important elements: temperature and humidity.

The estimates by the above experts include a 1 mm annual precipitation loss for the forthcoming 100-120 years and this trend is considered to be probable for the next few decades. The predicted rise in temperature, induced largely by artificial effects, is about 0.1-0.2 °C per decade (see Table 1), with a slight acceleration in its trend. This value is in harmony with the 0.20-0.50 °C per decade rise in the average global temperature (Roberts 1994).

Station	*Average of temperature rise, °C per year*	*T value*	*95% significance level*
Baja	0.011	5.718	yes
Kalocsa	0.011	5.727	yes
Kecskemét	0.011	5.332	yes
Szeged	0.010	4.519	yes

Table 1 *Temperature trends in the Danube-Tisza Interfluve*

These two trends suggest that the average temperature in the Danube - Tisza Interfluve may rise by a 0.5 °C in 20 years and by 1.0 °C in 50 years (Mika 1993). The annual rainfall is expected to decrease to below 500 mm, as compared to the present 550-600 mm, and that will not cover the water demand of the region (Figure 1).

The presented data sequences have direct and indirect ecological consequences. The most significant direct effect is the strong decrease in the water supply coupled with social effects. This will result in increasing aridification and a falling groundwater table (Figure 2). The calculations by Szász (1993) indicate thata 1 °C rise in temperature and a 5% fall in relative humidity will result in a 5-6% decrease in soil humidity (at the beginning of summer, it may even be more), while a 10% decrease in rainfall will cause a 2-4% decrease in soil humidity. The values are higher in spring and are unfavourably affected by the decreasing precipitation primarily in the spring and autumn. All of the above factors result in a decreasing water availability for the soils. The prognoses are based on the continuation and acceleration of this tendency. The other direct effect is the increasing duration of the vegetation period of plants.

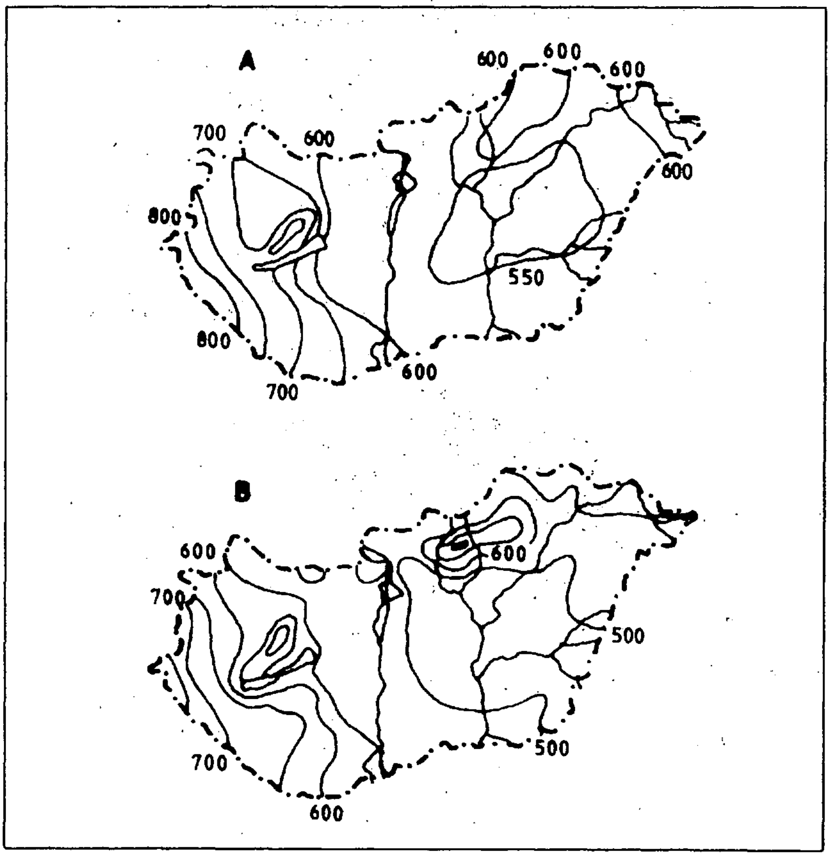

Figure 1 *(A) Distribution of mean annual rainfall (1901-1950).(B) Predicted mean annual rainfall due to 1 mm annual precipitation decrease in Hungary (after Szász 1993)*

The global changes may have favourable side-effects in the Carpathian Basin, besides the changes in the two climatic factors described above. For example, the larger amount of CO_2 will contribute to a greater effectivity of photosynthesis (Acock 1990), accompanied by a decreasing transpiration (which does not mean the decrease of transpiration in the whole of the vegetation).

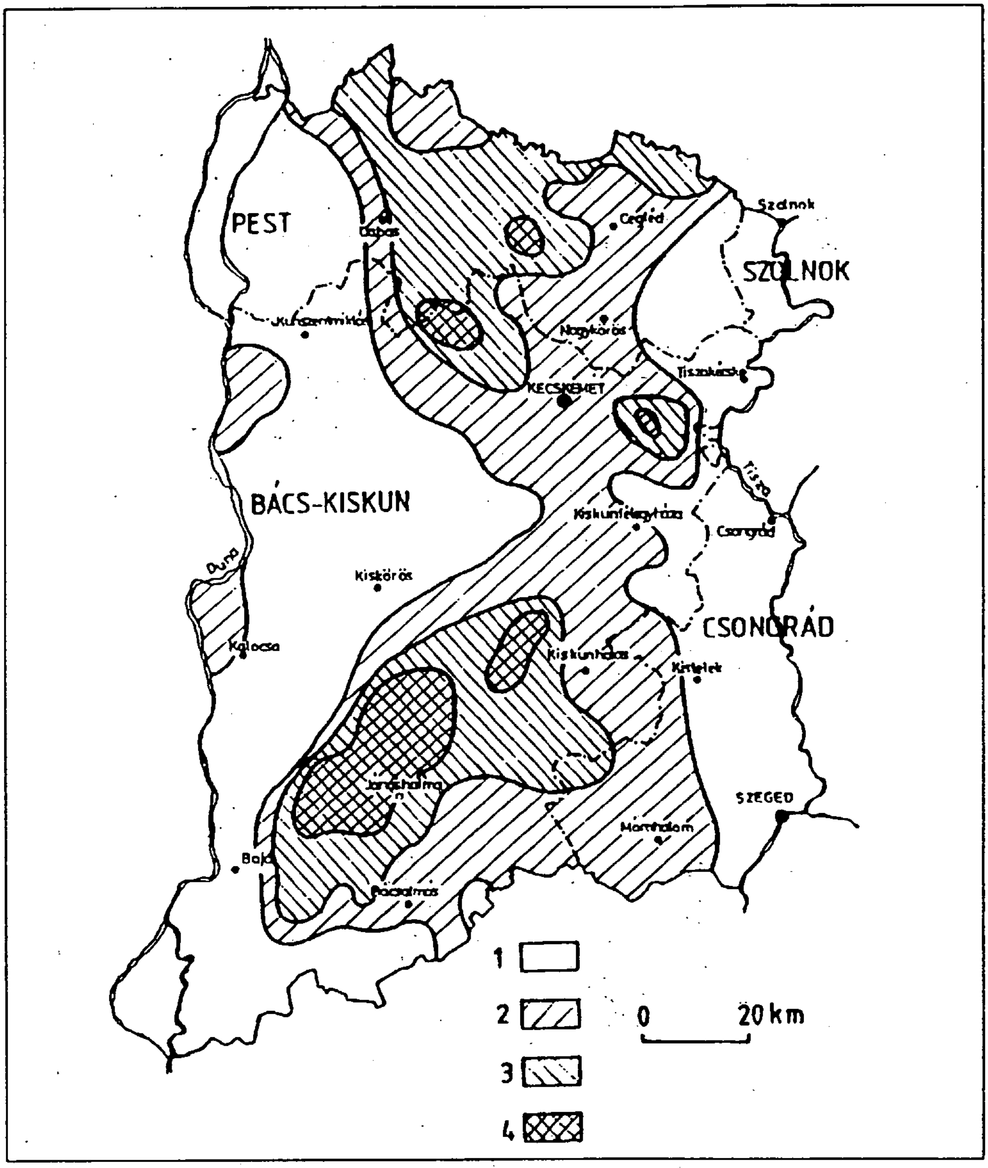

Figure 2 *Average groundwater level in Danube - Tisza Interfluve in early 1990s compared to average annual value from 1956 to 1975 (after Pálfai 1994). (1) < 1 m, (2) 1-2 m, (3) 2-3 m, 4 > 3 m*

Results

A. To elucidate the changed conditions of the ecotopes, we have made a detailed field survey of the the vegetation of the Danube-Tisza Interfluve (1:25,000) and ranked it into 24 vegetation types. A map presenting these in 5 categories (edaphic association groups) is shown in Figure 3. The maturity (the condition achieved in the succession line under the present land cover), the naturality (the association of the vegetation with the ecological capability) and the diversity are shown for each vegetation type. These parameters are then evaluated on a scale from 1 to 5, and the scores are summed. The values obtained in this way are used in landscape ecology as ecological values (Marks et al. 1989). Examination of the ecological values in the Danube - Tisza Interfluve (Figure 4 a) reveals that the highest (best) ranks are assigned to the flat, grove-covered depressions with a good water supply in the Danube Valley and the Danube - Tisza Interfluve; and the lowest values to the pusta associations (Categories II and III) determining the face of the landscape.

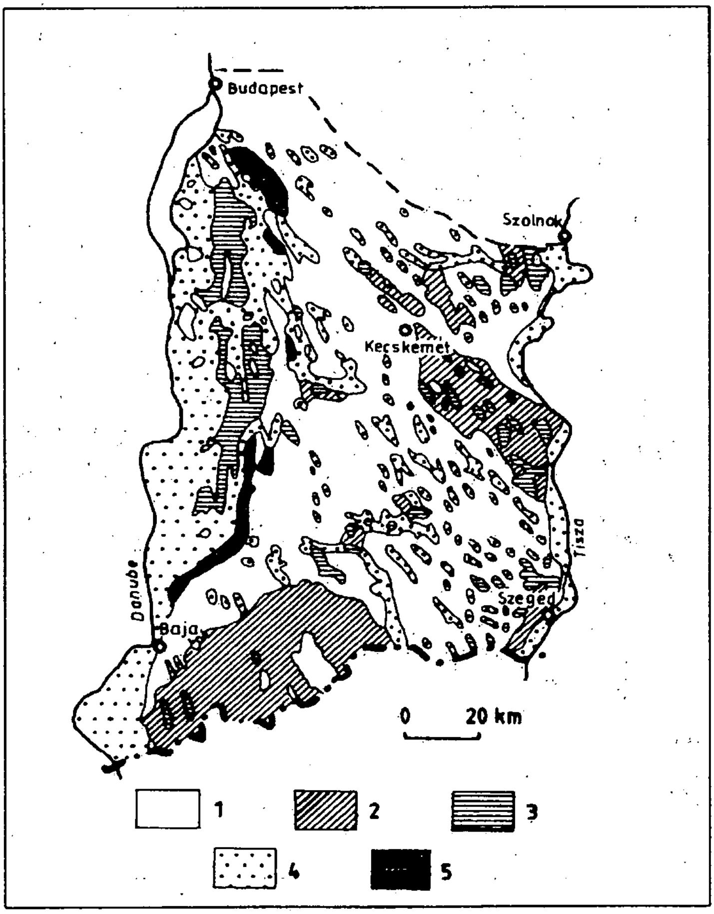

Figure 3 *Map of vegetation types (after Soó 1964). (1) Sandy oak groves and pusta; (2) loessy pusta, (3) alkali associations; (4) floodland gallery forests; (5) boggy meadows*

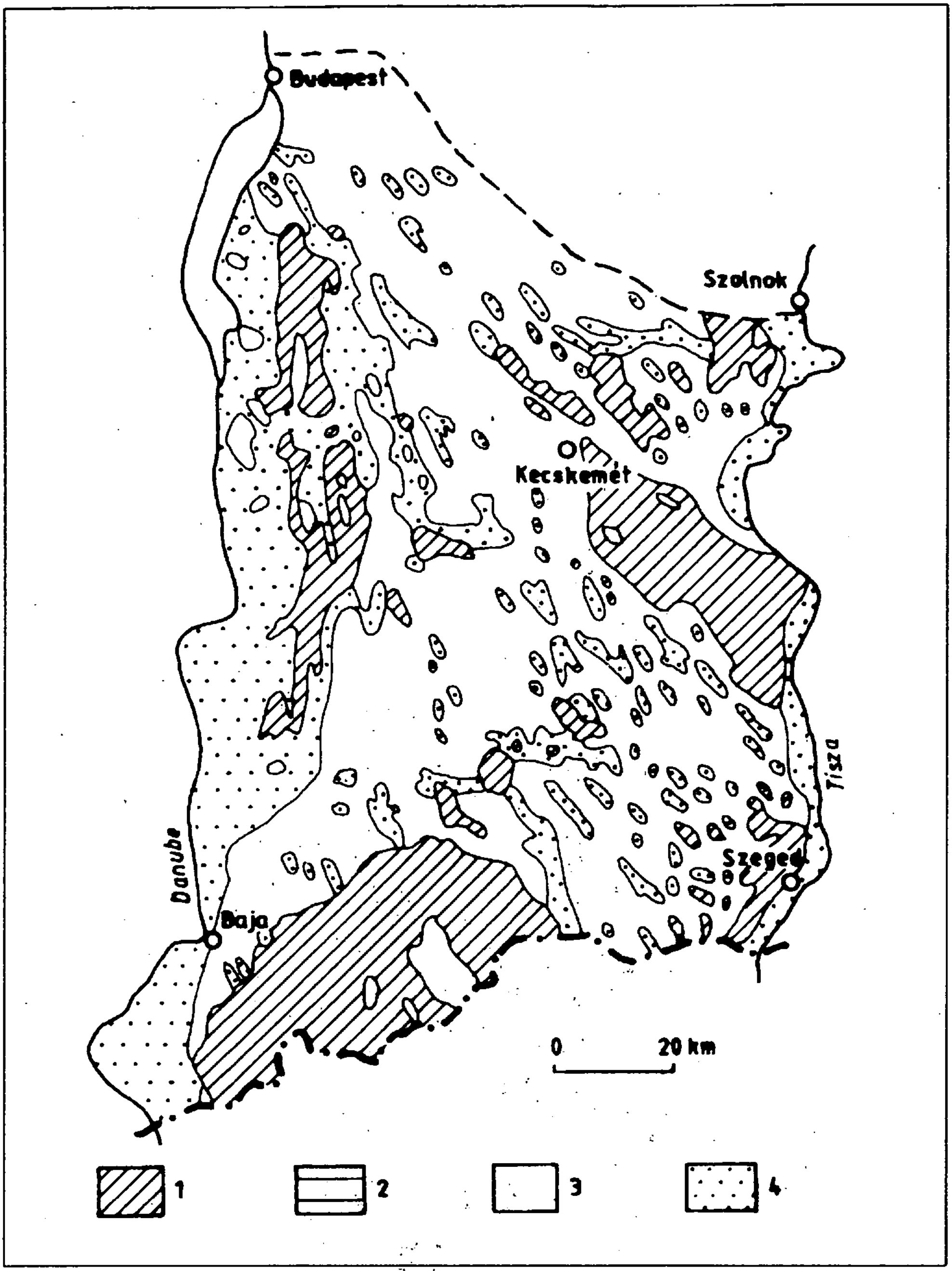

Figure 4a *Present ecological value of Danube - Tisza Interfluve. (1) < 8 points, (2) 8.5-10 points, (3) 0.5-12 points, (4) > 12.5 points*

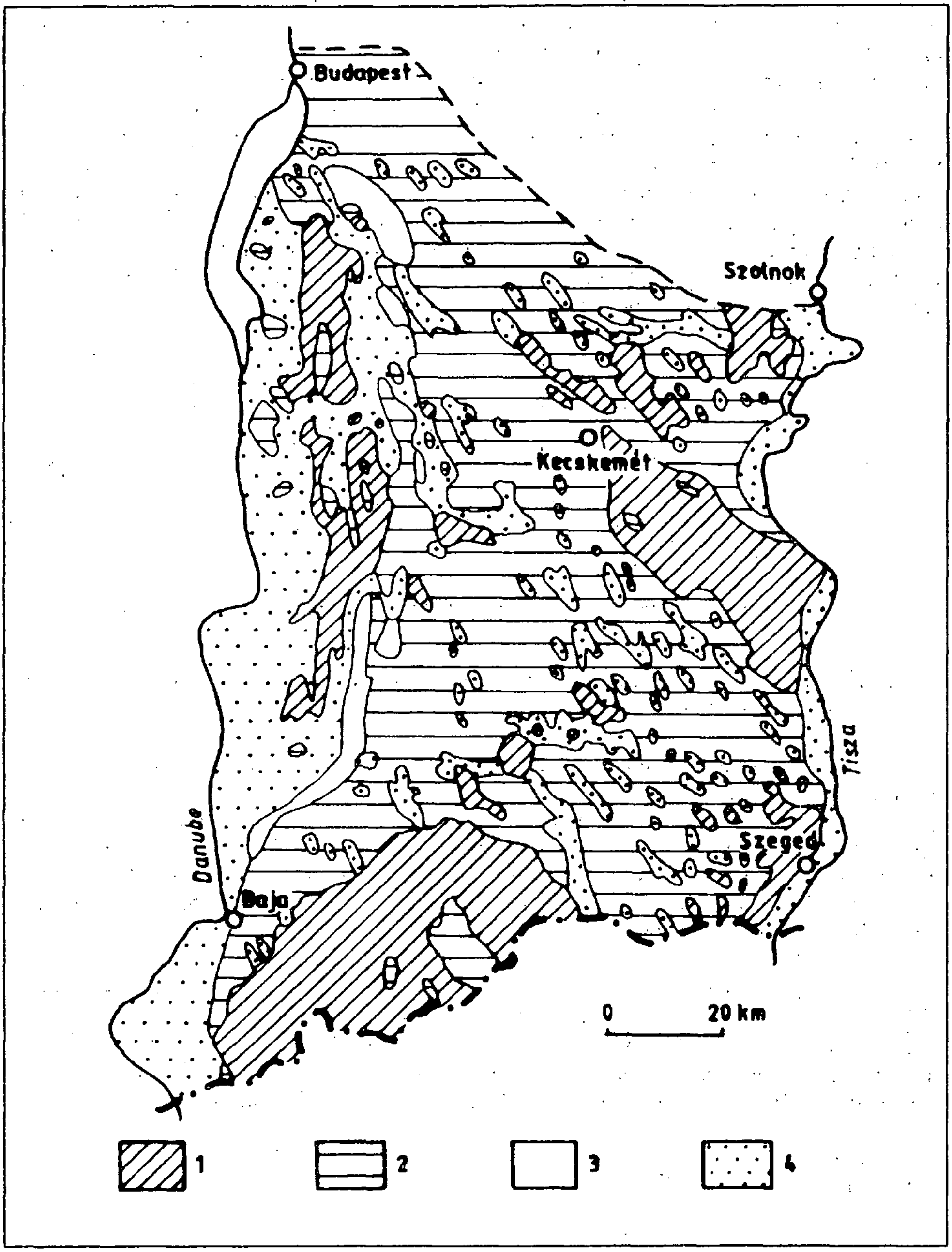

Figure 4b *Estimated ecological value of Danube - Tisza Interfluve. (1) < 8 points, (2) 8.5-10 points, (3) 10.5-12 points, (4) > 12.5 points*

The detailed ecological investigations in the Danube - Tisza Interfluve demonstrated the succession of the vegetation (Figure 5, after Soó 1964). From the estimated precipitation and temperature changes, the probable trend was reconstructed for each vegetation type, and their naturality, maturity and diversity were calculated together with their ecological values. The regional differences are to be seen in Figure 4 b. For the overall region, a slight decrease in the ecological values can be predicted (from 10.0 to 9.5, as in Table 2) in the case of the presumed climatic change. The values in Categories II and III will not actually change, though minor variations, may be expected in the vegetation associations, and the area of the closed sandy pusta steppe may be replaced at some sites by sandy pasture. The values in Category IV will not alter much, though the association will undergo a considerable change: the willow - poplar groves will be replaced by oak - elm growes. In categories I and V, the ecological values will decrease and the inner changes will be considerable.

Vegetation types	*Average ecological value*	
	at present	estimated
I. Sandy oak groves and pusta	10.5	9.0
II..Loessy pusta	7.5	7.5
III. Alkali associations	8.0	7.8
IV. Floodland gallery forests	12.6	12.6
V. Boggy meadows	11.5	10.5
Average	10.0	9.5

Table 2 *Present and predicted ecological value of vegetation types (a higher rank reflects a better ecological condition)*

For verification of the results, the factors limiting the evaluation also have to be considered: the vulnerability of the method is governed by these. The above - used scale is appropriate for an overall analysis of an area of some 10,000 km^2. The longer the forecast, the greater the errors that may occur in the estimation of the data because of the intensity of human activity on the Earth's surface. It therefore pointless to make estimates for a period longer than 50 years. The transformation of the vegetation may also be very variable as regards both dynamics and dimensions.

B. The change in productivity of the landscape can best be expressed in terms of NPP values. The NPP can be regarded as a direct (hard) landscape value. Because of the extent of the investigated area, we could not use the ecological methods devised for site measurements. The Miami Model (Leith 1974) has long been long used to determine the approximate NPP of large regions. In the calculations, we used the formulas

$NPP = 3000\,(1 - e^{-0.000364P})$ and
$NPP = 3000\,(1 - e^{-0.0009695(ET-20)})$,

where

P = annual average rainfall in mm, ET = actual evapotranspiration in mm, and NPP is in expressed g/m^2/year).

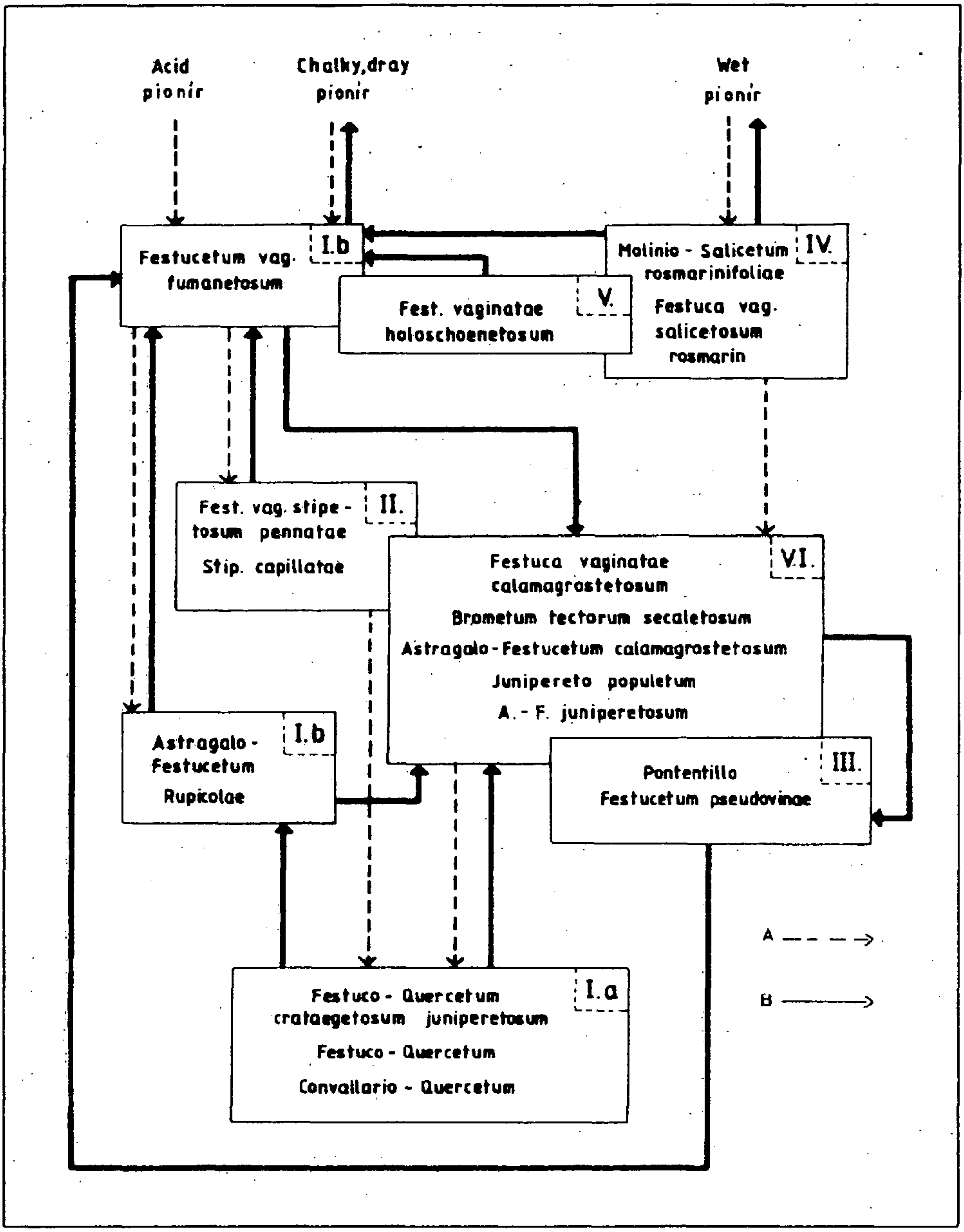

Figure 5 *Vegetation changes caused by climatic fluctuations and human effects in Danube - Tisza Interfluve (A) Normal succession, (B) succession with degradation trend: (Ia) sandy oaks, (Ib) sandy pusta, (II) loessy pusta, (III) alkali association, (IV) floodland and wet association, (V) boggy meadows, (VI) sandy grass with junipers*

There are various empirical formulas for the expression of NPP, involving both precipitation, and measured evapotranspiration. In our experiment, the different models yielded contradictory results: of the predicted climatic changes, the decreasing rainfall will cause a 10% drop in the NPP, while the rising temperature will result in a 2-3% increase. Thus, these models can be used for such a "small" region to give general information. What can be concluded from the calculations is that the natural productivity of the region is decreasing and the overall changes will cause a 6-8% NPP loss, wich may be doubled when the indirect NPP loss due to the fall in soil humidity is also considered.

C. Aridity, the main factor modifying the **use value**, is chiefly caused by the changing features of the climate, water utilization and drainage, and land use. If these factors are analysed separately, false results may be obtained. The development of land use is the most reliable aspect from which changes in use value can be checked (Figure 6). Ecological and economic changes are jointly responsible for the modifications, and thus an inaccurate record would be obtained if an attempt were made to establish the exact ecological change rate brought about by privatization, for example. Ecological factors automatically involve changes in utilization, which induce further processes. If the changes in the system of land utilization - albedo - groundwater are analysed, it can be concluded that the numerous factors modify the use value both positively and negatively. Tab.3 presents the modification in the rate of land use.

	1855	*1895*	*1935*	*1964*	*1985*	*1993*	*suggestion I*	*suggestion II*
Municipal areas	0.6	1.1	2.0	2.6	3.4	3.6	3-4	3-4
Forests	4.5	6.1	5.2	9.1	17.3	17.6	15-17	16-18
Arable land	37.9	53.5	58.8	64.1	62.2	63.3	30-55	38-52
Kitchen,gardens, vineyards,orchards	2.3	3.5	6.5	7.2	7.4	7.3	6-8	8-12
Meadows, pastures	39.8	29.0	21.2	16.0	9.7	8.2	20-30	20-30
Fallow	14.9	6.8	6.0	n.a.	n.a.	n.a.	5-20	
Albedo*100	22.5	21.7	21.6	20.6	19.6	18.7	20.6	22.1

n.a. = not available

Table 3 *Changes in land use and albedo rates in Danube-Tisza Interfluve*

Field measurements (Marosi-Somogyi 1991) and Landsat TM 4,5,3 (RGB) composites from 1993 were applied to differentiate the most important land use types, and revealed that large-scale social changes decreased the albedo, the ecological diversity and also the naturality. The decreasing albedo does not induce, but rather intensifies the aridity process produced for the above-mentioned reasons. We had believed that the expansion of the forests between 1855 and 1895, and between 1950 and 1985 also led to aridity, regardless of the fact that pines with a low water demand were planted in this region. Particularly the meadows and pastures were first affected by such changes in land use, which may have influenced the aridity process. After 1945, mostly arable land was afforested and thus aridity due to a"well-effect" cannot be proved. From the 1960s, melioration and dramatic changes in the water management of the interdune depressions (the local name is *semlye)* influenced the water supply to a larger extent. This resulted in subsequent setbacks such as the current fall in the water table and land alkalization (Kevei-Bárány 1988).

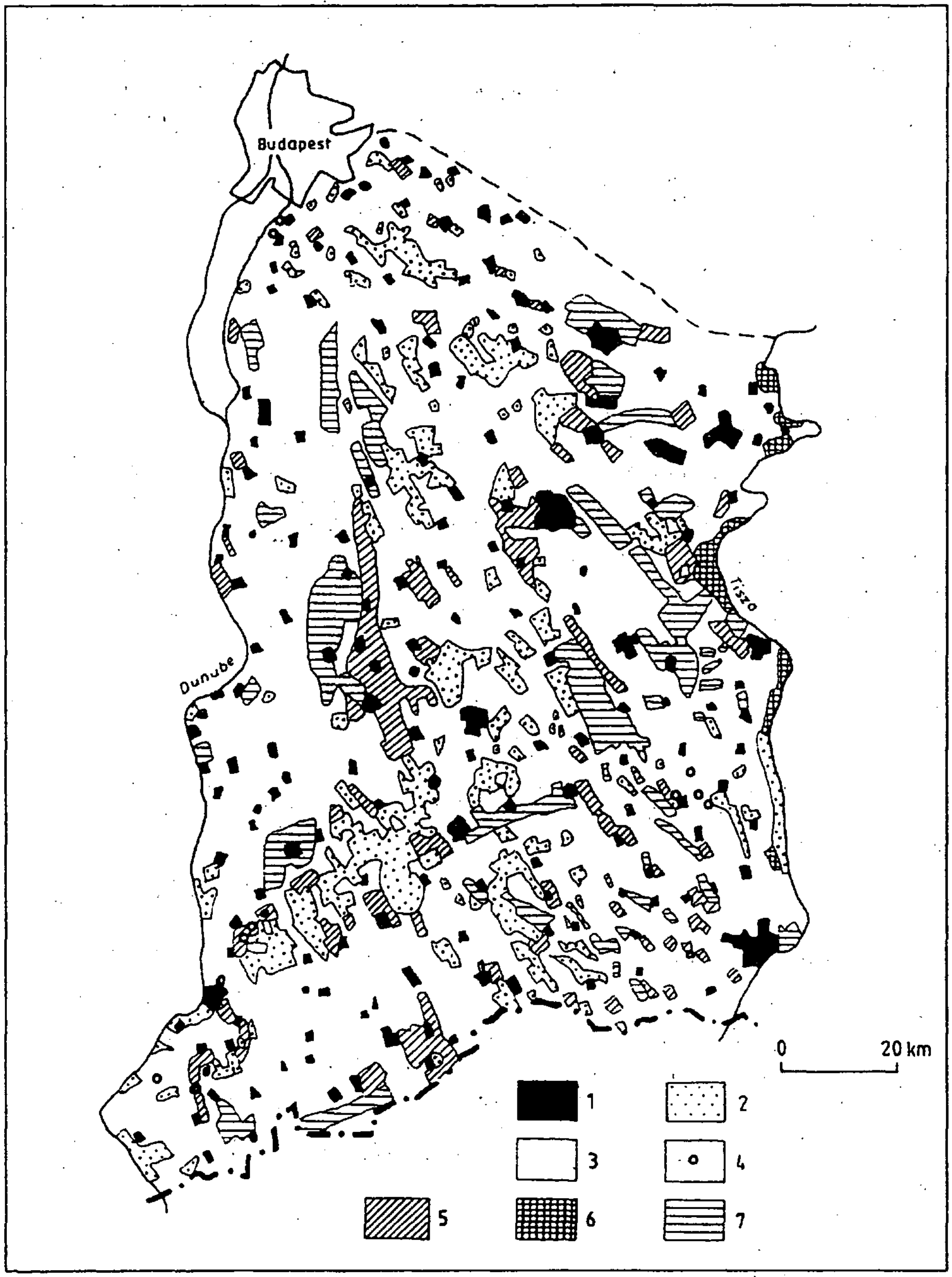

Figure 6 *Present land use of Danube - Tisza Interfluve. (1) Municipal areas; (2) forests, (3) arable land, (4) kitchen-gardens, (5) vineyards, orchards, (6) meadows, pastures; (7) alkali dry pasture*

From an ecological point of view the changes in land use have not been favourable. Grassplots, which carry natural vegetation best, have reduced significantly. This and arable land, which tends towards monoculturs, led to decline in the environmental structure, already sensitive because of the aridity. Larger plots of land predominantly understate ownership have caused increasing wind erosion (privatization has only led to a decreased plot size in a few places). Nowadays, more effective grassland farming (Table 3, suggestion II) and fallow-farming (Table 3, suggestion I) are emphasized.

The above factors influence the use value differently but often cumulatively within different areas. Figure 7 shows the distribution of the predicted change in the use value from an ecological aspect.

Discussion

The appearance of the Hungarian Pusta landscape after 30-50 years will depend mostly on man. If the currently estimated physical processes continue to prevail on the Pusta, we can expect the natural vegetation to transform into rather dry associations: weeds indicating diminishing diversity will become more widespread, as will the juniper at the expense of the oak - hornbeam groves. The competitiveness and acclimatization of the species will also change. The total ecological value of the vegetation cover will decrease. Some species will die out even within the areas of the national parks. Agriculture must be prepared for drier conditions than today. Especially the summer rainfall decrease will result in a need for drought - resistant species.

To summarizie the results of the climatic changes, it may be concluded in general that

a) certain species of plants will disappear due to their insufficient competitive ability and adaptability, while others will take over; still existing plants will be transformed genetically, and the proportion of weeds will increase;

b) because of the increasing danger of drought (the present frequency of droughty months will rise by 60%), agrotechnology must utilize the changing conditions of soil moisture, and this must be reflected in the crop structure, e.g. potato growing will reach a critical situation, while viniculture will improve (Mika 1993);

c) the resistance of the vegetation against environmental risks must be improved: this involves biodiversity, as well as irrigation, melioration and changes of species of trees;

d)it is most important to consider the different consequences of a value-oriented planning strategy and one based on principles of equity; the former is based on a modern value judgement system, and the latter on a projected one, with the aim of ensuring the maintenance of development.

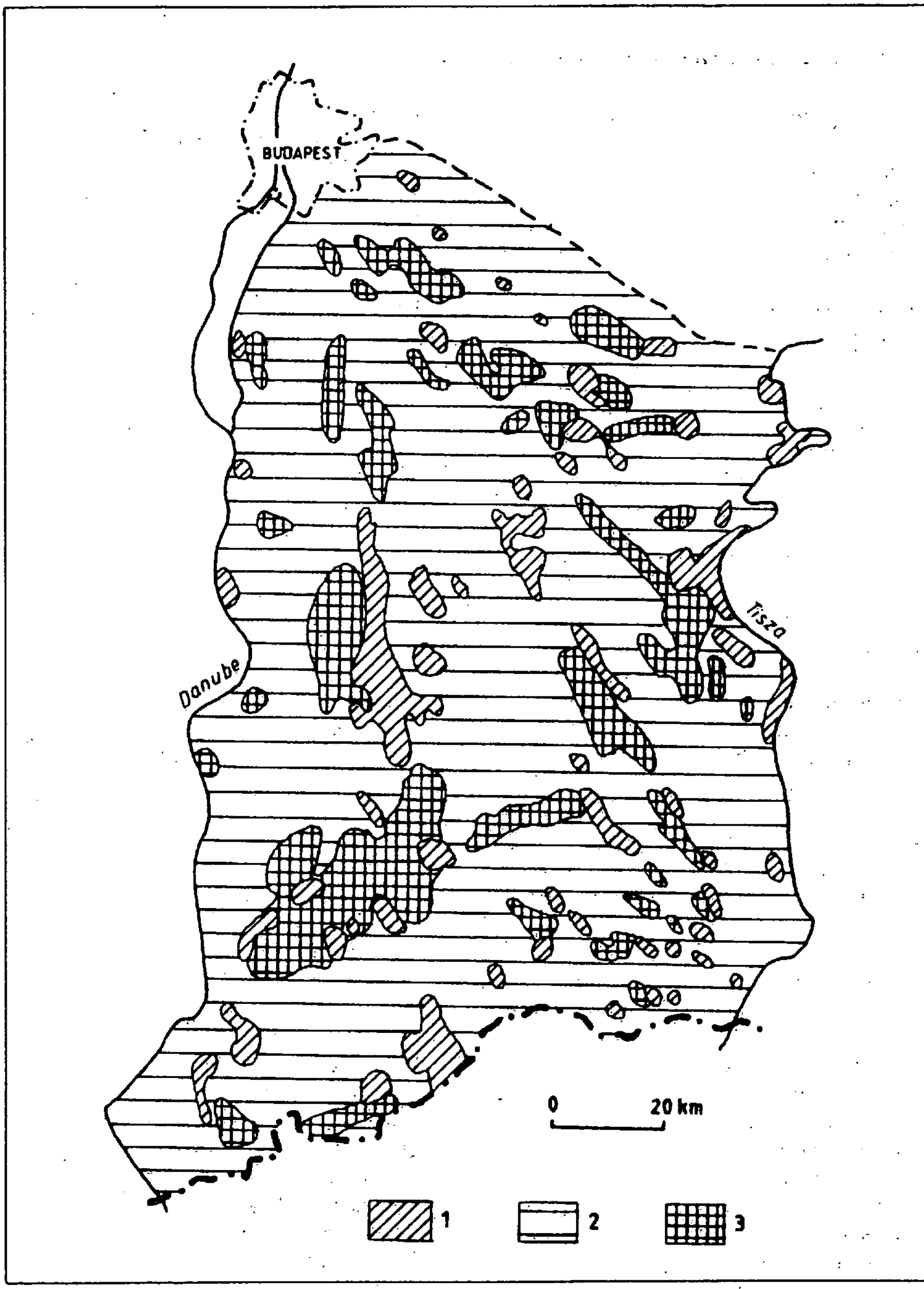

Figure 7 *Esimated change in use value from an ecological aspect in Danube - Tisza Interfluve. (1) Upgrade, (2) no fundamental change, (3) degradation*

APPENDIX

Oak forest with tatar maple on loess (Aceri tatarico - Quercetum pubescenti roboris)

Acer tataricum
A. campestre
Adonis vernalis
Ajuga laxmannii
Amygdalus nana
Anemone sylvestris
Betonica officinalis
Brachypodium pinnatum
B. sylvaticum
Cerasus fruticosa
Crategus monogyna
Dictamnus albus
Doronicum hungaricum
Euonymus verrucosus
Festuca rupicola
F. valesiaca
Filipendula vulgaris
Inula germanica
Iris variegata
Lithospermum purpureo-coeruleum
Melica altissima
muscari botryoides
Nepeta pannonica
Phlomis tuberosa
Polygonatum latifolium
Prunus spinosa
Quercus cerris
Qu. robur
Qu. petrea
Qu. pubescens
Rosa gallica
Thlaspi jankea
Ulmus minor
Vinca herbacea
Viola collina

Opened oak forest on sand (Festuco-Quercetum roboris)

Acer tataricum
Alkanna tinctoria
Allium sphaerocephalon
Amorpha fruticosa
Anemone sylvestris
Anthericum ramosum
Brachypodium sylvaticum
Calamintha clinopodium
Carex praecox
Crocus variegatus
Cornus sanguinea
Corylus avellana
Crategus monogyna
Cynanchum vincetoxicum
Elaeagnus angustifolia
Epipactis atrorubens
Euonymus europaeus
Festuca rupicola
F. vaginata
F. valesiaca
Filipendula vulgaris
Iris humilis ssp. arenaria
I. aphylla ssp. hungarica
Juniperus communis
Ligustrum vulgare
Melica transsylvanica
Peucedanum alsaticum
P. cervaria
Poa angustifolia
Poa nemoralis
Polygonatum odoratum
Populus alba
P. canescens
Pulsatilla hungarica
P. patens
Prunus spinosa
Polygonatum latifolium
Pyrus pyraster
Quercus pubescens
Qu. robur
Qu. cerris
Ranunculus illyricus
Salix rosmarinifolia
Stipa pennata
S.sabulosa

Juniper with poplar (Junipero-Populetum albae)

Rhamnus catharticus
Rubus caesius
Salix rosmarinifolia
Salvia pratensis
Senecio integrifolius
Seseli varium
Silene nutans
S. vulgaris
Solanum dulcamara
Solidago virga-aurea
Stellaria media
Stipa capillata
Taraxacum laevigatum
Teucrium chamaedrys
Thesium ramosum
Thalicrium minus
Thymus glabrescens ssp. subhirsutus
Tragopogon floccosus
Verbascum lychnitis
V. phoeniceum
Veronica spiccata
Vicia angustifolia
V. tetrasperma
Viola rupestris var. arenaria
V. hirta

Floodland forest with oak and ulmus (Fraxino pannonicae - Ulmetum)

Aegopodium podagraria
Allium ursinum
Alnus glutinosa
A. incana
Anemone ranunculoides
Brachypodium sylvaticum
Carex remota
C. strigosa
Cephalanthera rubra
C. longifolia
C. damasonium
Convallaria majalis
Cornus sanguinea
Corydalis cava
Corylus avellana
Crataegus monogyna
Epipactis helleborine
E. microphylla
Equisetum hyemale
Fraxinus angustifolia ssp. pannonica
F. excelsior
Gagea lutea
Galanthus nivalis
Galium odoratum
Hedera felix
Impatiens noli-tangere
Lilium bulbiferum
Lithospermum purpureo-coeruleum
Malus sylvestris
Orchis militaris
O. purpurea
Padus avium
Parietaria erecta
Populus alba
P. canescens
Polygonatum multiflorum
P. latifolium
Pulmonaria officinalis
Quercus robur
Sanicula europaea
Scilla bifolia
Ulmus laevis
U. minor
U. scabra
Viburnum opulus
Vinca minor
Vitis sylvestris

Closed oak forest on sand (Convallario - Quercetum roboris)

Acer campestre
Acer tataricum
Athryum filix-femina
Berberis vulgaris
Betula pendula
Brachypodium sylvaticum
Campanula bononiensis
Carex michelii
Convallaria majalis
Coridalis cava
Cornus sanguinea
Corylus avellana
Crategus monogyna
Dictamnus albas
Doronicum hungaricum
Dryopteris filix-mas
Euonymus europaeus
Ficaria verna
Gladiolus imbricatus
Inula salicina
Iris hungarica
Ligustrum vulgare
Lithospermum purpureo-coeruleum
Muscari botryoides
Ophys insectifera
Orchis purpurea
O. militaris
Platanthera bifolia
Poa nemoralis
Polygonatum latifolium
Populus alba
P. tremula
Pyrus pyraster
Quercus robur
Scilla vindobonensis
Tilia tomentosa
Ulmus minor
Viburnum lantana
Viola hirta

Juniper with poplar (Junipero-Populetum albae)

Achillea millefolium
Ajuga genevensis
Anthriscus cerefolium ssp. trichosperma
Asparagus officinalis
Berberis vulgaris
Brachypodium silvaticum
Bromus sterilis
Calamagrostis epigeios
Carex liparicarpos
C. flacca
Centaurea sadleriana
Cephalanthera rubra
Chondrilla juncea
Colchium arenarium
Conium maculatum
Coronilla varia
Crataegus monogyna
Cynoglossum hungaricum
Echinops ruthenicus
Euonymus verrucosus
Eryngium campestre
Euphorbia cyparissias
Farcaria vulgaris
Festuca rupicola
Fragaria vesca
Galium aparine
G. mollugo
G. verum
Juniperus communis
Koeleria glauca
Ligustrum vulgare
Lithospermum officinale
Lotus corniculatus
Medicago minima
M. falcata
Melandrium album
Muscari racemosum
Onosma arenaria
Phleum phleoides
Pimpinella saxifraga
Poa pratensis
Polygonatum odoratum
Potentilla arenaria
Populus alba
Prunella vulgaris
Prunus spinosa
P. mahaleb
Ranunculus acer

Floodland forest with willow and poplar (Salicetum albae-fragilis)

Agrostis stolonifera
Alnus glutinosa
A. incana
Carex gracilis
C. riparia
C. vesicaria
Galium palustre
Laecojum aestivum
Myosotis palustris
Phalaris arundinacea
Phragmites australis
Poa palustris
Polygonum Mite
Populus nigra
Rorippa amphibia
Rubus caesius
Salix alba
S. fragilis
Stachis palustris
Typhoides arundinacea
Ulmus laevis
Urtica dioica

Alkali sedge field (Agrosti-Caricetum distantis)

Achillea asplenifolia
Agrostis alba
Aster tripolium ssp. pannonicum
Bolboschoenus maritimus
Carex distans
C. paniculata
C. acutiformis
Centaurea pannonica
Cirsium brachycephalum
Dactylis glomerata
Eleocharis palustris ssp. uniglumis
Euphorbia palustris
Festuca arundinacea
Holoschoenus romanus
Inula britannica
Juncus articulatus
Lapidium crassifolium
Linum perenne
Lotus corniculatis ssp. tenuifolius
Ononis spinisa
Orchis laxiflora ssp. palustris
Poa trivialis
Plantago maritima
P. major
Polinia coerulea
Polygala comosa
Potentilla reptans
Ranunculus acer
Rhinanthus glaber
Rorippa silvestris ssp. kerneri
Sanguisorba officinalis
Serratula tinctoria
Taraxacum officinale
T. bessarabicum
Teucrium scordium
Thalictrum simplex var. galioides
Tetragonolobus siliquosus
Trifoliuimfragiferum

Alkali vegetation on solonchak (Lepidio-Camphorosmetum annuae)

Artemisia monogyna
Aster tripolium ssp. pannonicus
Camphorosma annua
Cynodon dactylon
Erophila verna
Festuca pseudovina
Kochia prostata
Lepidium crassifolium
L. cartilagineum
Limonium gmelini
Matricaria chamomilla
Plantago maritima
Polygonum aviculare
Potentilla arenaria
Puccinellia limosa
Sedum saxangulare
Statice gmelini
Suaeda maritima

Alkali vegetation on solonetz (Lepidio-Puccinellietum limosae)

Agrostis alba
Aster tripolium ssp. pannonicus
Bupleurum tenuissimum
Carex distans
Cerastium dubium
Champhorosma annua
Chenopodium glaucum
Cichorium intybus
Crypsis aculeata
Cynodon dactylon
Festuca pseudovina
Juncus compressus
Lepidium crassifolium
L. perfoliatum
Matricaria chamomilla
Nostoc commune
Phragmites communis
Plantago maritima
P. schwarzenbergiana
Puccinellia distans ssp. limosa
Spergularia marginata
Suaeda maritima
Taraxacum bessarabicum
Trifolium fragiferum

Alkali mud assotiation (Suaedetum maritimae hungaricum)

Crypsis aculeata
Chenopodium glaucum
Salicornia ramosissima
Suaeda maritima
S.pannonica

Alkali reedy (Boloboschoeno-Phragmitetum)

Agrostis stolonifera
A. alba
Artemisia maritima
Aster tripolium ssp. pannonicus
Atriplex hastata
Bolboschoenus maritimus
Chenopodium chenopodoides
Eleocharis uniglumis
Heliocharis palustris
Lotus corniculatus ssp. tenuifolius
Phragmites australis
Plantago maritima
Puccinellia distans
Spergularia marginata
Schoenoplectus tabernaemontani
Trifolium fragiferum

One year grassland on sand (Brometum tectorum secaletosum)

Anthriscus cerefolium subs. trichosperma
Arenaria serpyllifolia
Bromus squarrosus
B. sterilis
B. tectorum
Carex liparocarpos
Cynodon dactylon
Equisetum ramosissimum
Kochia laniflora
Medicago minima
Polygonum arenarium
Secale silvestris
Syntrichia ruralis
Tragus racemosus
Tribulus terrestris ssp. orientalis

Closed steppe on sand (Astragalo-Festucetum rupicolae)

Astragalus asper
A. exscapus
Althaea officinalis
Andropogon ischaemum
Carex praecox
Centaureum uliginosum
Chrysopogon gryllus
Cynodon dactylon
Crataegus monogyna
Festuca rupicola
F. pseudovina
Gagea pusilla
Iris humilis ssp. arenaria
Stipa capillata
S. sabulosa
Juniperus communis
Muscari racemosum
Ononis spinosa
Populus alba
Polygala comosa
Salvia pratensis
Veronica prostrata v nemorosa
Verbascum austricum
Verbascum lychnitis

Swamp meadow with Festuca (Festuco rupicolae - Salicetum rosmarinifoliae)

Anthericum silvestris
Anthyllis vulneraria ssp. polyphylla
Arabis recta
Asparagus officinalis
Asperula cynanchica
Astragalus austriacus
A. onobrychis
Botriochloa ischaemum
Bromus squarrosus
Calamagrostis epigeios
Campanula sibirica
Carduus nutans
Carex arenaria ssp. tauscheri
C. liparicarpos
Coronilla varia
Cynanchum vincetoxicum
Erigeron acris
Erophyla verna
Eryngium campestre
Euphorbia cyparissias
E. seguieiriana
Festuca rupicola
F. vaginata
Galium verum
Inula salicia v. denticulata
Iris humilis ssp. arenaria
Linaria genistifolia
Linum austriacum
Onosis spinosa
Medicago falcata
Muscari racemosum
Odontites lutea
Onobrychis aranifera
Phleum phleoides
Poa angustifolia
P. bulbosa
Potentilla arenaria
Salvia pratensis
Saxifraga tridactylites
Scorzonera purpurea
Secale silvestris
Seseli annuum
Stachys recta
Stipa capillata
Syrenia cana
Teucrium chamaedrys
Thesium arvense
Thymus marschallianus
Trogopogon floccosum
Verbascum lychintis
V. phoeniceum
Veronica prostata
Viola kitaibeliana

Opened grassland on sand (Festucetum vaginatae danubiale)

Achillea ochroleuca
Alkanna tinctoria
Alyssum tortuosum
Arenaria sarpyllifolia
Artemisia campestris
Astragalus varius
Calamagrostis epigeios
Calamintha acynos
Camelina microcarpa
Carex liparicarpos
Centaurea arenaria ssp. tauscheri
Colchium arenarium
consolida regalis
Crepis rhoeadifolia
Cynodon dactylon
Dianthus serotinus
D. pontederae
Echinops ruthenicus
Ephedra distacya
Equisetum ramosissimum
Erophila verna
Eryngium campestre
Euphorbia cyparissias
Festuca vaginata
Fumana procumbens
Galium verum
Gypsophila arenaria
Holoschoenus vulgaris
Iris humilis ssp. arenaria
Koeleria glauca
Linaria genistifolia
Medicago minima
Minuartia glomerata
Odontites lutea
Onosma arenaria
Phleum phleoides
poa angustifolia
Polygonum arenarium
Silene otites ssp. pseudotites
Stipa sabulosa
S. borysthenica
S. capillata
Sedum hillebrandtii
Salix rosmarifolia
Salsola kali ssp. ruthenica
Secale silvestris
Syrenia cana
Teucrium chamaedris
Tragopogon floccosum
Thymus marschallianus
Tragus racemosus
Verbascum lychnitis

Noncalcareous grassland on sand (Festuco-Corynephoretum)

Festuca vaginata
Corynephorus canescens
Kochia laniflora
Jasione montana
Rumex acetosella

Alkali meadow with Puccinella (Puccinellietum limosae)

Agrostis alba
Aster tripolium ssp. pannonicus
Juncus gerardi
Lepidium crassifolium
Plantago tenuiflora
P. maritima
P. schwarzenbergiana
Polygonum aviculare
Puccinela limosa
Scorzonea cana
Taraxacum bessarabicum
Triglochin maritimum

Boggy-sedge with Menyantes (Carici-Menyanthemum)

Agrostis alba
Carex elata
Cirsium palustre
Comarum palustre
Dactylorhiza incarnata
Dianthus superbus
Epipactis palustris
Eriophorum vaginatum
Glycerina maxima
Iris sibirica
lysimachia vulgaris
Menyanthes trifoliata
Phalaris arundinacea
Senecio paludosus
Valeriana officinalis

Whither swamp meadows (Succiso-Molinietum coeruleae)

Agrostis alba
Anacantis pyramidalis
Achillea asplenifolia
Briza media
Carex distans
C. panicea
Cirsium rivulare
C. oleraceum
Dianthus superbus
Festuca arundinacea
Galium boreale
Genista tinctoria
Gentiana pneumonanthe
Leontodon hispidus
Lysimachia vulgaris
Molinia coerulea
Pinguicula vulgaris
Poa trivialis
Potentilla erecta
Ranunculus acris
Sanguisorba officinalis
Serratula tinctoria
Succisa pratensis
Tetragonolobus maritimus

Swamp meadow with Molinia (Molinio-Salicetum rosmarinifolie)

Agrostis alba
Achillea millefolium
Carex flacca
Festuca pseudovina
Galium verum
Holoschoenus vulgaris
Leontodon autumnalis
Molinia coerulea
Ononis spinosa
Potentilla reptans
Salix rosmarinifolia
Schoenus nigricans
Tetragonolobus maritimus

Swamp meadow with Juncus (Juncetum subnodulosi)

Blysmus compressus
Caltha palustris
Carex acutiformis
C. elata
C. hirta
C. lepidocarpa
C. riparia
Deschampsia caespitosa
Euphorbia palustris
Eleocheris palustris
E. quenqueflora
Eriophorum angustifolium
E. latifolium
Equisetum palustre
Galium uliginosum
G. palustre
Gratiola officinalis
Iris pseudacorus
Juncus inflexus
Juncus subnodulosus
Mentha aquatica
M. longifolia

Orchis laxiflora ssp. palustris
Poa trivialis
Ranunculus bulbosus
R. repens
Sanguisorba officinalis
Scutellaria hastifoli
Scorzonera parviflora
Schoenoplectus lacustris
S. tabernaemontani
Taraxacum paludosum
Tatragonolobus maritimus
Thrincia nudicantis
Triglochin maritimum
Typhoides arundinaceaa
Valeriana dioica

Swamp meadow with Schoenus (Schoenetum nigricantis)

Carex flacca
C. lepidocarpa
C. leporina
C. panicea
C. vulpina
Cirsium brachycephalum
Equisetum palustre
E. variegatum
Hypericum tetrapterum
Parnassia palustis
Scorzonera humilis
S. hispanica
S. parviflora
Senecio paludosus var. tomentosus
Schoenus nigricans
Valeriana dioica
Veratrum album
Iris sibirica
Iris spuria
I. pseudocarpus
Orchis laxiflora ssp. palustris
O. incarnata
O. militaris
O. morio
O. coriophora
Phragmites
Potentilla erecta
Polygala comosa

Loess pusta with Achillea (Achilleo-Festucetum pseudovinae)

Achillea collina
A. setacea
Alopecurus pratensis
Artemisia monogyna
Carex ctenophylla
C. praecox
Eryngium campestre
Euphorbia cyparissias
Festuca pseudovina
Inula britanica
Limonium gmelini
Lotus corniculatus
Medicago falcata
M. lupulina
Melandrium viscosum
Mentha pulegium
Ornithogalum gussonei
Poa bulbosa
Ranunculus pedatus
Scorzonera cana
Trifolium campestre
T. dubium
T. retusum
T. striatum
Veronica orchidea

Alkali pusta with Artemisia (Artemisio-Festucetum pseudovinae)

Aster tripolium ssp. pannonicus
Artemisia maritima ssp. monogyna
Achillea collina
Camphorosma annúa
Eragrostis pilosa
Festuca pseudovina var. salina
Gypsophila muralis
Hordeum hystrix
Inula britanica
Lepidium crassifolium
Limonium gmelini
Mentha pulegium
Matricaria chamomilla var. salina
Plantago tenuiflora
P. maritima
Poa bulbosa var. vivipara
Puccinellia limosa
Rorippa silvestris ssp. kerneri
Scorzonera cana
Trifolium angulatum
Statice gmelini

Weed assotiation of river-bed (Chenopodium fluviatile)

Ambrosia elatior
Bidens tripartitus
Calystegia sepium
Chenopodium album
Ch. polyspermum
Cyperus fuscus
Echinochloa crusgalli
Equisetum palustre
Matricaria inodora
Polygonum hydropiper
P. lapatifolium
Stachys palustris
Veronica anagalloides
Xanthium strumarium
X. italicum
X.riparium

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References

ACOCK, B. Effects of CarbonDioxide on Photosynthesis. Plant Growth and other processes. ASA Special Publication, No.53 - ASA-CSSA-SSSA, Madison, WI, USA - 45-60.

ASZTALOS I. - SÁRFALVI B. 1960. A Duna-Tisza köze mezőgazdasági földrajza. Akad. Kiadó, Budapest p.394

FEKETE, G. 1992 The holistic view of succession. Coenoses 7. (1) pp. 21-29

KERESZTESI, B. 1971. A magyar erdők. Akadémiai Kiadó p. 431

KEVEI-BÁRÁNY, I. 1988. Talajföldrajzi vizsgálatok Szeged környékén. Alföldi Tanulmányok 1988. pp. 25-31.

LEITH, H. 1974. Phenology and seasonality modeling. Springer, Berlin-Heidelberg p. 444

NAVEH, Z. - LIEBERMANN, A. 1984. Landscape Ecology. Sringer, New York p. 323

MARKS, R. - MÜLLER, M. - LESER, H. 1989. Anleitung zur Bewertung des Leistungmögens des Landschaftshaushaltes. Forschungen zur Deutschen Landeskunde Band 229. Trier, p. 222
MAROSI, S. - SOMOGYI, S. (ed.) 1991. Magyarország kistájainak katasztere. MTA FKI Budapest I-II. köt. p. 1023
MÁRKUS, F. 1995. A hagyományos mezőgazdasági művelés szerepe az Alföld természeti képének kialakulásában. in: Alföldi Mozaik. KTM 2. Budapest, pp. 65-98.
MIKA, J. 1993. Az Alföld éghajlatának megváltozása a globális klimaváltozás összefüggésében (Climatic changes in the Alföld in relation to global climatic change). Alföldi Tanulmányok, Békéscsaba XV. pp. 11-31.
MOLNÁR, K. 1994. Magyarország tájainak éghajlati bemutatása feltételezett klimaváltozás setére. Kand ért. tézisei Budapest p. 19
PÁLFAI, I. 1994. Összefoglaló tanulmány a Duna-Tisza közi talajvizszint süllyedés okairól ... in: Pálfai, I. 1994. A Duna-Tisza közi hátság vizgazdálkodási problémái. Nagyalföld Alapitvány kötetei 3. Békéscsaba pp. 111-126.
RODGE, H. 1990. Treasuring the environment. The Economist 1990. 3rd March p. 63
SIMON, T. 1980 Növényrendszertani terepgyakorlatok, Tankönyvkiadó, Budapest, p. 144
STEFANOVITS, P. 1981. Magyarország talajai. Akadémiai Kiadó, Budapest p. 252
SOÓ, R. 1964, 1966, 1968. A magyar flóra és vegetáció növényföldrajzi kézikönyve. I.-II.-III.Akadémiai Kiadó, Budapest p. 589
SZÁSZ, G. 1993. Az éghajlatváltozás szerepe a növénytermesztés stratégiájában (On the role of cimatic change in the cultivation strategy of plants). OMSZ Budapest LIX. pp. 9-23.
VARGA-HASZONITS, Z. 1993. Az éghajlati változékonysság és a növénytermesztés (Climatic variability and plant breeding). OMSZ Budapest LIX. pp. 24-41.
VERMES, L. 1995. Az esetleges éghajlatváltozás és a mezőgazdaság (Effects of possible climatic change on agriculture). Journal of Hung. Hydrological Society Vol. 75. No.2. pp. 101-106.

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ON THE GEOLOGY AND GEOMORPHOLOGY OF VIGYÁZÓ MOUNTAINS (Vlădeasa)

Róbert Géczi - László Gruber

Introduction

Knowing the geomorphological surfaces of the study area, the Vigyázó Mts, is essential for the survey of the planated mountainous regions. Geomorphologic surface practically answers the orographic surface of known genetics. All its development cycles are known, representing the stages of elevating surface formations. If the investigated area did not undergo post-orogenesis, the uppermost geomorphological surface is the oldest and the underlying ones are younger. Geomorphological surfaces are being buried in the sinking structural formations. Geomorphological surfaces of the Transylvanian Inselbergs have been being elevated some 1000 m during the old and new Roumanian tectonic movements up to now. Elevation is 1-2 mm a year.

Vigyázó Mts (Vlădeasa) are situated in the central northern part of the Transylvanian Inselbergs (Muntii Apuseni), see Figure 1. The 600 km^2 large, 35-40 km long mountain range form a horseshoe and open to the north. Its geomorphological surfaces have not been yet surveyed. We have some general information only on the classic planated areas. The field work done ensures the description of the geomorphological surfaces.

The mountains are considered as part of Bihar by Szádeczky (1904), csíki (1941) and Savu (1982). They are mentioned as Bihar in studies published in the beginning of the century. In spite of this, their geology and geomorphology define them as a meso-region, a seperate mountain range.

The Vigyázó is situated in a tectonic trough system. Its geological structure includes banatite and dacite with crystalline shale in the west and Mesozoic sediments; mainly limestone in the south (Figure 2).

Formation of the planated surface

Planated surfaces are mainly large, plain or slightly rolling products of long degradation.

Several authors (de Martonne, 1922; Cotet, 1977, Nordon, 1933) dealt with the planated surfaces of the Inselbergs and the Southen Carpathians (Carpatii Meridionali). De Martonne (1907) outlined three seperate peneplains of different ages. These are the Borăscu (at 1800-2200 m), the Râu-Ses (at 1300-1800 m) and the Gornovita (at 400-1000 m). The equivalent surfaces were identified in other ranges of the Southern Carpathians. E.g. Nordon (1933) in the Radnai Mts defined the Nedeia, Batrăna and Stiol surfaces and the Poina Ciungi, Dorna, Bîda surfaces in the Beszterce Mts. They are named Semenic, Tomnacica and Teregova in the Szörényi Mts (Rosu, 1980).

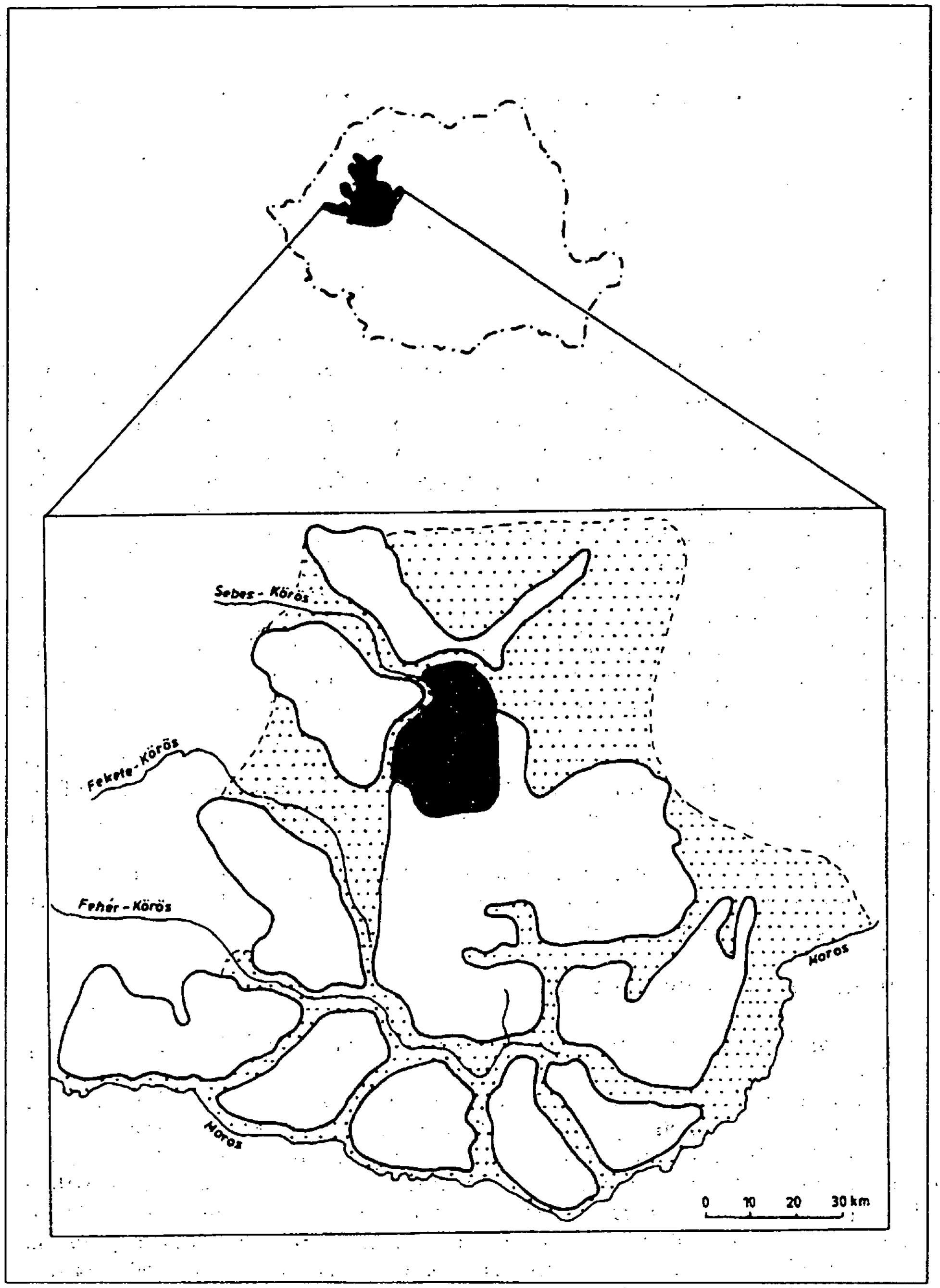

Figure 1 *Location of the Transylvanian Inselberg including the Vigyázó Mts*

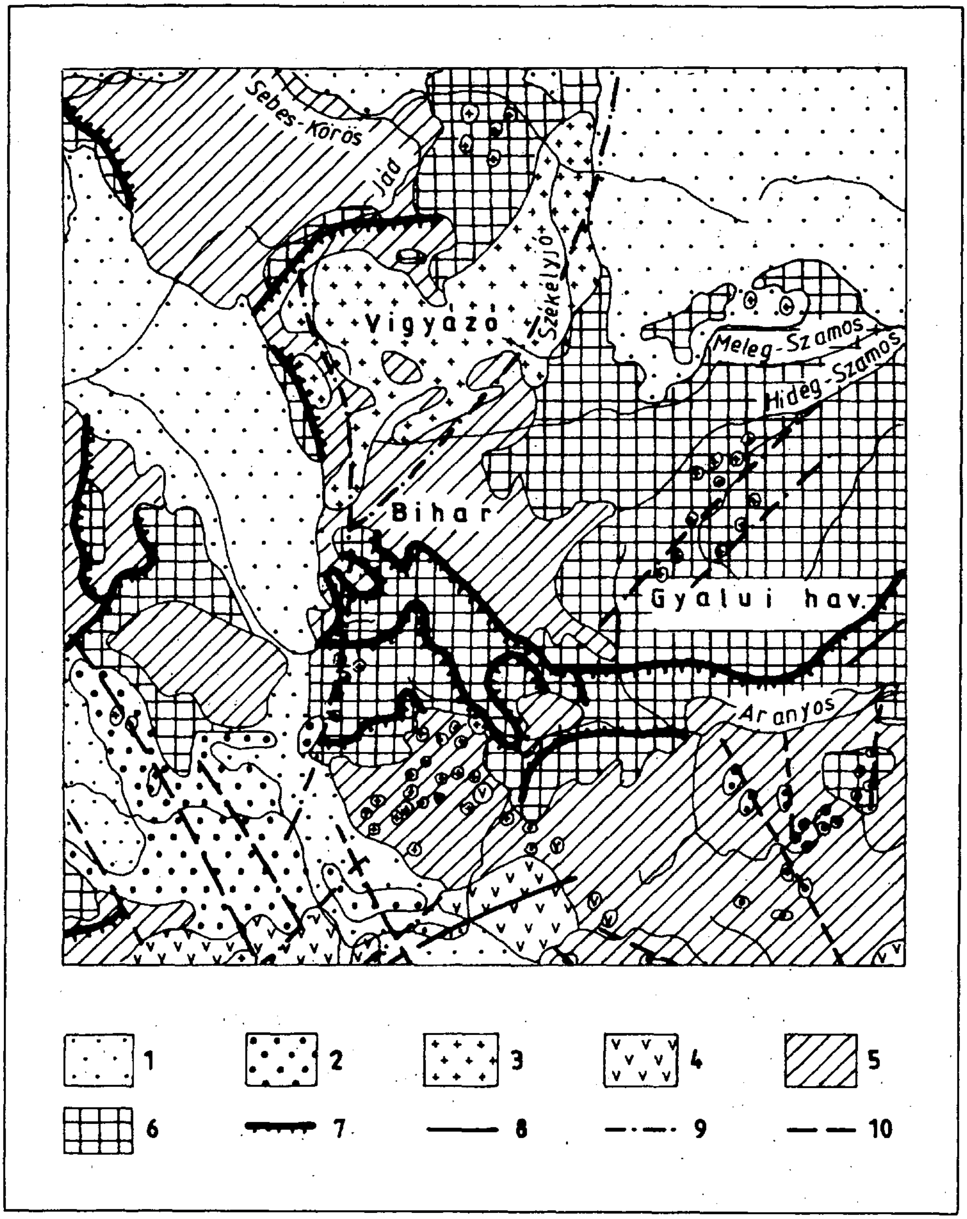

Figure 2 *Draft of the geological and petrogenetic lines*
1 - Tertiary, intramontane sediments, 2 - Subsequent neogene magmatism
3 - banatites, 4 - initial magmatism, 5 - Mesozoic sediment sequence
6 - Prealpine basement, 7 - faults and overthrust zones,
major petrogenetic lines: 8 - ophiolites, 9 - banatites, 10 - Neogene volcanics

The three erosional surfaces in the middle of the Transylvanian Inselbergs are named Fãrcas, Mãrisel and Fenes (de Martonne, 1992). Referring to the dominating rock type, Blehau M. names the surfaces in the Torockó Mts (Ciumãrna-Bedeleu, Râmet-Ponor and Nades) as karst planines (Vecea, Savu, 1982).

According to de Martonne, the highest planated surface is Eocene. Pedimentation following elevation took place then, burying the Lower-Cretaceous layers with Lutecian deposits on top. This is the opinion of Nordon, while Gh Pop claims the oldest surface be of Cretaceous origin (Rosu, 1980). The second surface is Pannonian according to de martonne, while in Cotet's opinion it is but a transitive zone between the upper and lower denudation surfaces. The peneplane is a coherent massive block, not made of small parts of different ages. It was formed between Upper Creta and Oligocene. Cotep says that this large block of peneplane was dissected by the Styrian, Moldavian and Attic epirogenetic movements. Thus the Borescu and the Râu Ses are parts of the once massive block elevated to different heights. According to de Martone, the Lower-Sarmatian-Pliocene surface is of complex origin that is to say an erosional, accumulative and abrasional (Baden-Pliocene) pediment (Cotet, 1977). After a correlative examination of the sediment layers exposed in the Zsibó (Jibou) Basin, they were found to have been formed during the Creta Period. Thus climatic morphological and paleogeographical surveys allow us to consider the Vigyázó Mts in the Inselbergs as one planated surface (Farkas-Fãrcas) that has been dissected and elevated in different degrees. No planated surface from the Upper-Creta Period has been proved to exist here, though their formation might as well be possible. The denudation of the Farkas surface began in the Upper-Creta. The presence of the Gosau and flysch facies proves the intensive peneplanization before the Lamian epirogenetic movements. After the Laramian tectonic activity, pedimentation till the end of Eocene played an important role in the formation of the present morphology of the Carpathians. In this period the Vigyázó Mts got into a relative tectonic balance, got elevated from the sea and became dry all over.

During the Upper Maastrichtian and Danish orogenesis, favourable climatic conditions for denudation were dominating. Kaolinite was formed under and owing to the humid tropical climate. The area of the mountains had been dryland till the Ypresian and Lutecian Age, then, parallel with the elevation of the mountains, its pediments began to sink along the post-formed faults. The tectonic elevation and sinking continued throughout the Paleogene. Meanwhile, in the underlying layer of the detritus cover, the Predanish surface was exposed, then eroded completely owing to the areal and linear erosion and chemical weathering begun in the cracked rock surface. During the Lutenian transgression and the following sinking, pedimentation did not work. Denudation slowed down in the peneplanes, due to climatic effects. At the end of the Lutenian Period and at the beginning of the Lattorfian one, there was another elevation. The deposited aleurit sand proves the renewed pedimentation in the Oligocene. Chemical weathering was rather limited under the unfavourably cool climatic conditions.

The Savian movements occurring at the transition between the Kattian and Acquitanian Periods, the Baden sinking, the general tectonic instability and the cool climate drove the denudation processes to the pediment surface. Thus the more or less coherent, homogeneous, planated, Danish-Rupelian block surface was dissected by the Styrian, Baden-Sarmatan Moldavian and Upper Sarmatian Attic movements.

Unlike the Bihar Mts, there are five planated surfaces to be spot in the Vigyázó Mts (Figure 3).The first and the highest surface is that of the Horgas Mt (Cârligati). It includes the peaks of Tolvajoskő (Piatra Tâlharului 1621 m), Horgas (1691 m), Bocsásza (Buteasa 1792 m), Kis-csúcs and the wide, plain ridge of the Vigyázó. This surface encompasses the Néma (Nimăiasa) and Mikó (Micău) Mts over 1600 m. The most perfect, plain surface can be found in the south, in the zone of the Horgas and the 1759 m high Sík-havas (Britei) Mts.

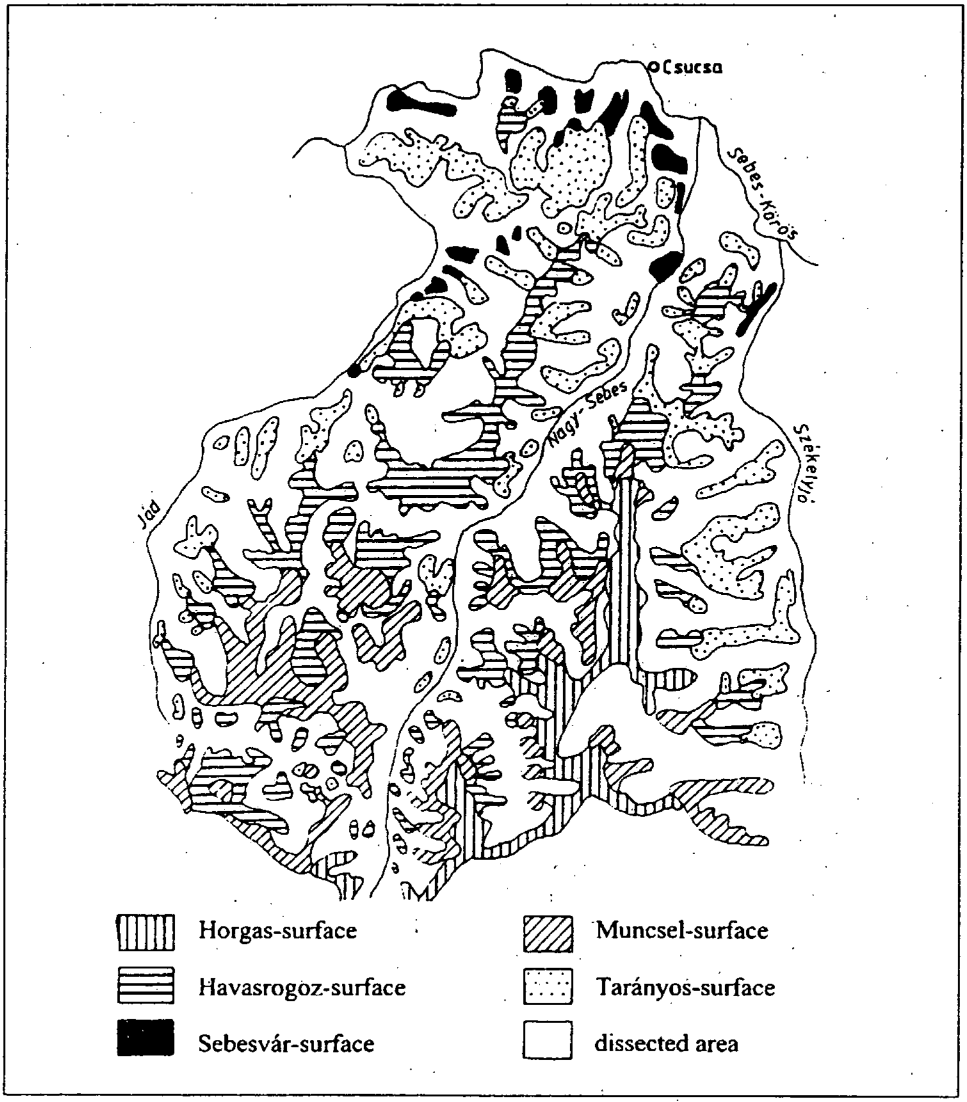

Figure 3 *Planated surfaces of the Vigyázó Mts*

The following surface, the Muncsel (Muncelu) got its name from the wide, flat divide between the Jád and the Nagy-Sebes. Its average elevation is around 1500 m. The lowest part of it can be detected at the Ördöngös Peak (Ordincusa) on 1014 m. This surface can be found as islands, west of the flat ridge of the Vigyázó and along the Zerna (Zârna) Stream flowing into Nagy-Sebes. It is answers the block surface described by Mãrisel.
The third surface, the Havasrogoz (Rogojel) is named after a village on 1100 m. The centre of the settlement of scattered houses is on 1019 m above sea level. Much of this surface is situated between the Jád and the Nagy-Sebes in N-S direction. In the valley heads near Biharfüred Basin (Stâna de Vale) it is situated on 1200-1300 m, therefore it can be easily mistaken for the upper surface. According to de Martonne (1922) this surface is situated at the junction of the planated block surfaces of Fãrcas and Mãrisel. Isolated, it appears in the west of the Bánffyhunyad Basin too.

The Tarányos (Tranis) surface can be found in the plateau of the village of the same name (Tarányos-Magura 947 m), and on the heights along the Sebes streams and the Jád, like on the Bükkös Plateau (Podisul Frãsinet).

The last, the lowest surface is that of Sebesvár (Bologa) along the Sebes-Körös, the Kis-Sebes and the lower section of the Jád on 700 m. Allong the Sebes-Körös it can be spot on 500 m right above the oldest terrace.

Conclusions

The Farkas (Fãrcas) block is a real peneplane with five surfaces and is the result of denudation processes having occurred under a favourable tropical climate intensifying chemical weathering which had a significant role in widening the valleys and in the degradation and peneplanation of the inselbergs. The following tectonic processes disecceted the homogeneous surface, elevating its parts into different heights. The Farkas peneplane and all the other planated, similar surfaces of the Carpathians were formed between the Danish and Upper Oligocene Periods.

Literature

Cotet P. (1977): Problemes de géomorphologie historique en Roumanie. La pénéplation des Carpates occidentales et méridionales. Bucuresti, pp. 552-557.
Csíki G. (1941): Adatok az erdélyi dácitok ismeretéhez. Földt. Közl. LXXI Bpest, p. 107-108.
de Martonne, Emm. (1907): Recherches sur l'évolution morphologique des Alpes de Transylvanie. Rev. géogr. ann.
de Martonne, E.(1922): Sur les plates-formes d'érosion des mont du Bihar (Roumanie),Paris.
Nordon, A. (1933): Resultates sommaires et provisorie d'une etude morphologique des Carpathes orientales roumaines. Congr. intern. geogr.,II 1, Paris.
Posea, Aurora (1977): Bazinul Crisul Repede. Ed. Stiintificã si Enciclopedicã, Bucuresti.
Rosu, Al. (1980): Geografia fizicã a României. E.D.P., Bucuresti pp. 64-66, 323-329.
Szádeczky Gy. (1904): Adatok a Vlegyásza-Biharhegység geológiájához, Földtani Közl., Bp.
Velcea, V., Savu, Al.(1982): Geografia Carpatilor si a Subcarpatilor Românesti. E.D.P., Bucuresti, pp. 197-207.

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PLANT ECOLOGICAL SURVEY OF THE KATARÉTI STREAM CATCHMENT

Ilona Bárány-Kevei - Károly Barta - Györgyi Tamási

Intorduction

On the NE pediments of the Mátra Mts, on the catchment of the Katarét Brook, the Physical Geographical Department of the JATE carried out a plany survey in the frame of a complex geoecological investigation, the aim of which being the completion of a geoecological map. Such a map cannot ignore the survey of plant associations affected by human activity.

The method of Marks, R., Müller, M.J., Lesser, H. and Klink, H.J. (1989) to examine the landscape potential, offers a possibility to digitize and evaluate the functions and processes within landscape. From among these functions the ecotop-building and the areal nature conservation ones are introduced in brief in this study, then, after choosing some associations with characteristic differences, the temperature budget (T), water budget (W), the soil reaction (R) and the nitrogene demand (N) of their ecological requirements are described in turns, species by species. The evaluation of ecological indicator values reveals the tendencies of change in the natural and in the disturbed associations.

The ***association types*** of the area are various due to morphology (Figure 1). On the upper surfaces (5-700 m), ***mainly natural, mesophyllic, mixed deciduous woods*** can be found. In smaller spots, there are rather disturbed ***dry rock*** and ***pusta grassy associations*** on a surface covered with shallow soil. In the valleys and around the springs there are ***hygrophytic associations*** along the brooks in strips, easy to be detected on maps. These associations link the areas under natural and technical effects and the areas being already seperated by the effects of human activity. In this sense they function as ecological corridors and support plant life to spread and survive. In this catchment, ecological corridors are especially important, since the E-W parts along the brooks are seperated by extensive cultivated lands. The associations along the brooks in the N and S parts of the catchment area play an especially important key role in it, since they have preserved their natural condition rather than the associations along the brooks in the middle of the catchment. Unfortunately, these hygrophytic associations are also disturbed, owing to agricultural activity in their immediate neighbourhood; or because they border associations being highly degraded. ***Clearing meadows*** are also found here. They are secondary associations and consequently they are rather poor in species, their diversity is low. In and around Bodony village situated in the middle of the catchment, there are ***wine*** and ***fruit plantations, orchards and parks*** as well. In a previous study (Mezősi G.- Kevei Bárány I.- Balogh I.- Mucsi I.- Farsang A. 1993) the stability of the association types was

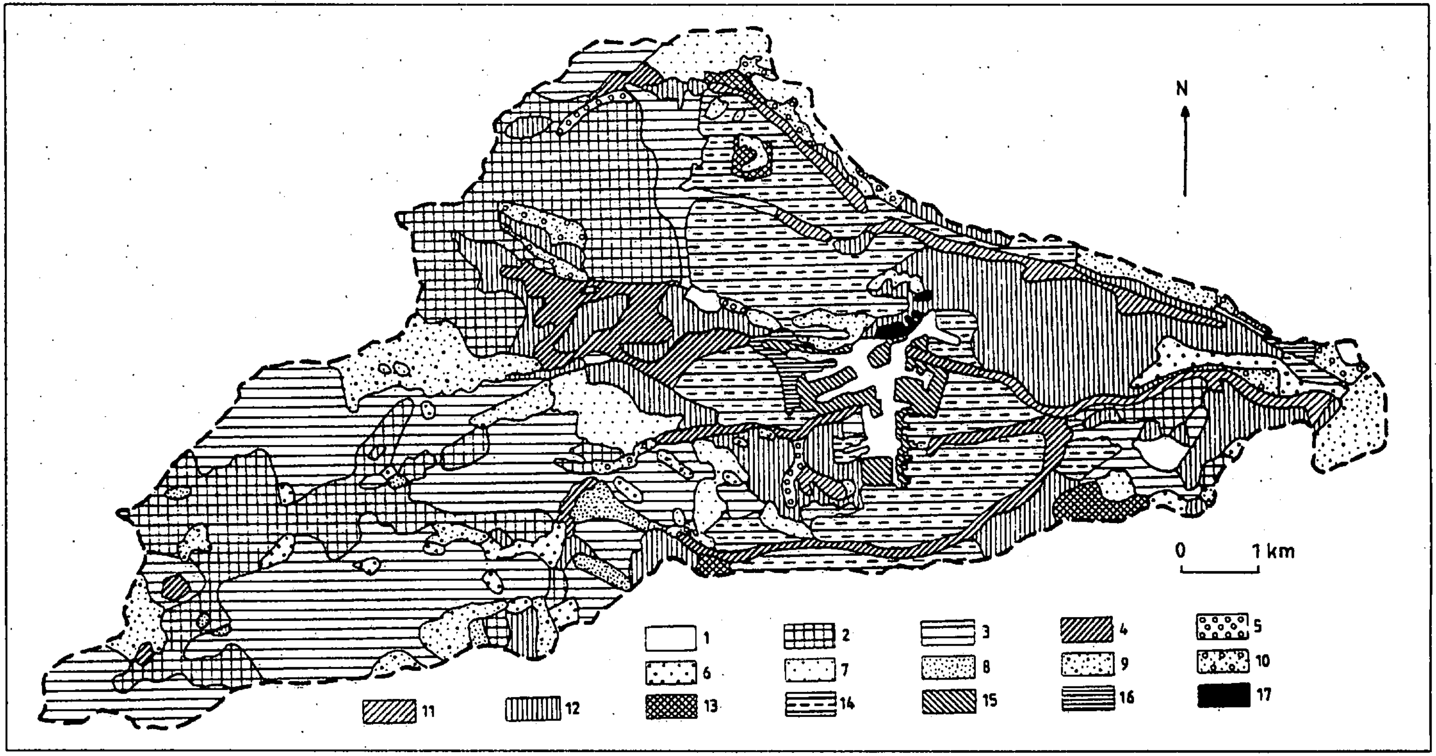

Figure 1 *Types of vegetation on the Katurét Brook Catchment*
1= settlement, quarry, 2=mesophytic deciduous and mixed forest, 3=dry groves, bushy associations, 4=swamp and marsh woods, 5=humid groves, 6=planted forest pinery, 7=planted deciduous woods, 8=young, planted deciduous woods, 9=planted mixed woods, 10=bushy associations, 11=associations of eutrophic waters and springs, 12=associations of calciphilous meadows, 13=perennial rudeal and weedy meadows, 14=croplands, 15=little orchards, parks and sportfields, 16=fruit trees, 17=vineyards and hop plantations

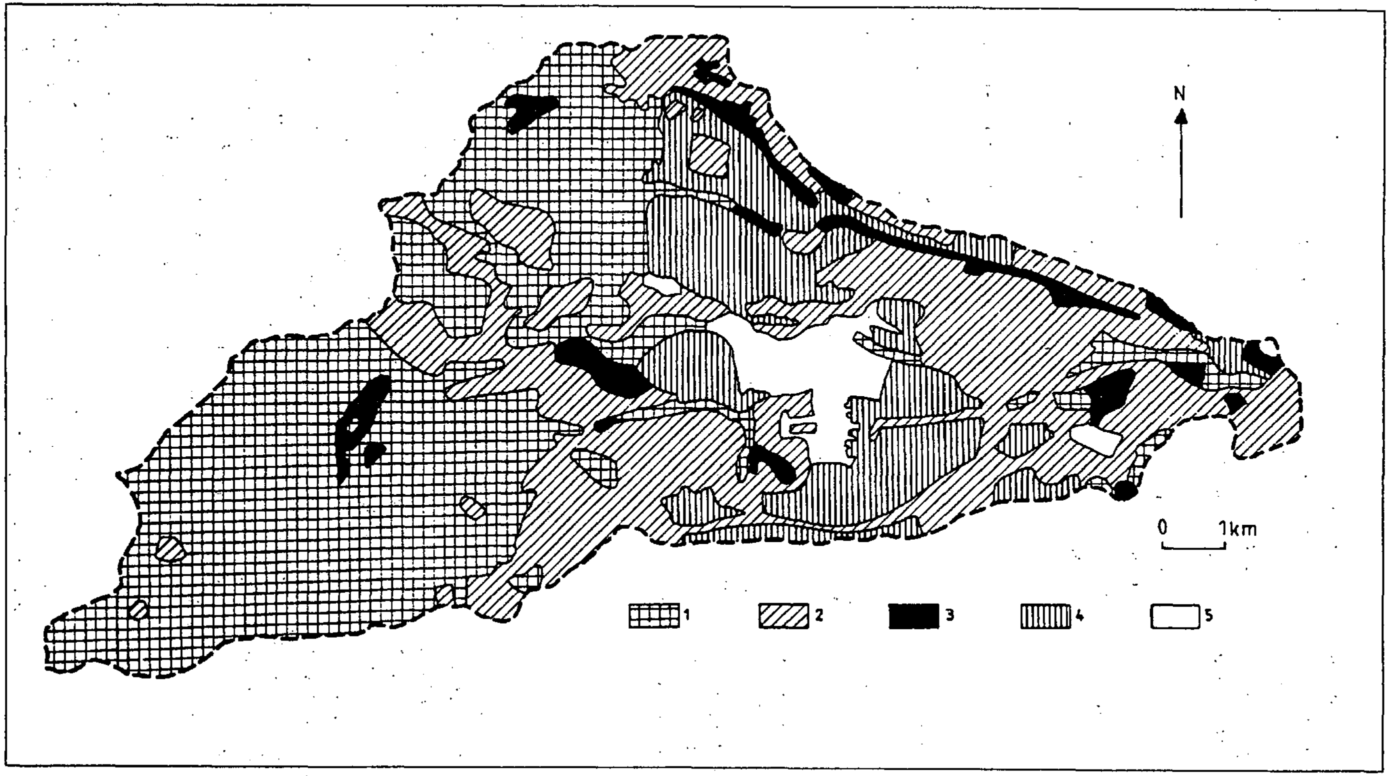

Figure 2 *The place of the Katarét Brook Catchment associations in the natural succession sequence*
1=mature (closing) associations, 2=degrading associations, 3=initial or developing associations, 4=agricultural field, 5=settlement

examined in this test area. The ***mixed woods*** and the ***grassy associations*** were found to have a ***strong relative stability***. The ***hygrophytic plants*** have low or prestable condition, while the associations under the effects of human activity are ***unstable***. The nature conservation value to be described in detail further on, also proves the low stability of hygrophytic plants.

The degree of human effects, the diversity, naturality and maturity of the associations define the ecotop-buildig function of the plants. The ***stage of the natural succession sequence of the association*** has also to be considered in the evaluation. From this viewpoint there are three types chosen (Figure 2). The maturity, structuredness and diversity are lower with the associations being in an initial phase than those of the mature asociations. Such ***initial associations*** are most of the ***rock and pusta grassy*** and ***bushy*** ones. The ***mature (closing) associations*** have the highest number of species and structurednesss for each type. This phase is represented in the investigated area by ***beeches, hornbeam and oak groves, mixed deciduous woods and pineries***. The third phase of ***degradation*** represents the unfavourable human effects. There are large sites, especially on the ***clearings; clearing meadows, patches of rock and pusta grass*** and a part of the eutrophic aquatic associations. The territory of the settlement and the croplands are not evaluated from this aspect, since they can only contribute to the extention of the degraded areas, their natural indicators being too low in values.

Ecotop-building function of assotiation

The quality of the ***ecotop-building function*** is the output of summarizing the values of maturity, naturality, diversity, structuredness and harmful human effects. The values range from 1.5 to 20 in the test area (Table 1). The values of the ecotop-building factor are high in the mixed deciduous woods, especially in the beeches and hornbeam-oak groves (16-20). The mixed and pine woods have slightly lower values (8.5-16), while cultivated lands, orchards, vineyards have very low (1.5-8.0) values. The ***ecotop-building function represents the stability of the associations*** of a given area. If the ecotop-building value is higher, the stability, the renewing and regenerating capability of the plants will be stronger. The ecotop-building function have values higher than 10 in more than half of the test area. Thus the present use of the environment cannot be considered dangerous.

Nature conservation function of assotiation

When establishing the nature conservation function, the rarity and endangeredness of the domestic plant species were examined. Their being endangered was calculated from their degree of protection. There are three stages of protection answering their nominal values. Species worth 10 000 Forints were considered as directly endangered. Between 10-5000 Fts they were classified as actually endangered, while at 5000 Fts, potentially endangered.

The volume of protected plants is little in this catchment area though, so the ***nature conservation function*** is defined mostly by the ***present value of the vegetation***, its ***renewing capacity*** and the ***period of its development***. The nature conservation value changes between 4 and 50 (Table 2). The deciduous forest and the adjoining underwood have high nature conservation values, though their nature conservation function is versatile.

Table 1.
Ecotop-building function of the different assotiations in the Katarét Brook Catchment

Assotiation type	M	N	A	S	D	B	ÖBW
2	5	5	5	3	4	5	19.00
3	4	5	4	3.3	3.65	4	16.65
4	5	5	4	3.5	3.75	5	18.75
5	4	5	3	2.6	2.80	4	15.80
6	4	3	2	1.7	1.85	3	11.85
7	4	3	4	3.3	3.65	4	14.65
8	3	3	3	2.4	2.70	3	11.70
9	4	3	4	3.1	3.55	4	14.55
10	3	3	3	2.4	2.70	3	11.70
11	4	5	4	1.8	2.90	5	16.90
12	3	3	3	1.1	2.05	3	11.50
13	2	1	2	1.5	1.75	2	6.75
14	1	0	1	1.0	1.00	1	3.00
15	2	0	1	1.9	1.95	2	5.95
16	2	0	1	0.9	0.95	1	3.95
17	2	0	1	0.5	0.75	1	3.75

M = maturity
N = naturality
S = structural diversity
A = abundance of species
D = diversity
B = human impact
ÖBW = ecotop-building function

2 = mesophytic deciduous and mixed forest
3 = dry groves, bushy assotiation
4 = swamp and marsh woods
5 = humid groves
6 = planted forest pinery
7 = planted decidous woods
8 = young, planted decidous woods
9 = planted mixed woods
10 = bushy assotiation
11 = assotiations of eutriphic waters and springs
12 = assotiation of calciphilous meadow
13 = perennial rudeal and weedy meadow
14 = croplands
15 = little orchards, parks and sportfield
16 = fruit trees
17 = vineyards and hop plantations

Table 2.
Nature conservation function of the different assotiationsin the Katarét Brook Catchment

Assotiation type	ÖBW	RL	G	P	E	NSW
2	19.00	2	2	2	10	35.00
3	16.65	2	2	2	10	32.65
4	18.75	1	1	3	10	33.75
5	15.80	0	1	5	5	26.80
6	11.85	0	1	2	4	18.85
7	14.65	1	1	2	4	22.65
8	11.70	0	1	2	4	18.70
9	14.55	2	2	2	4	24.55
10	11.70	1	1	4	3	20.70
11	16.90	2	1	3	1	23.90
12	11.05	2	2	2	3	20.05
13	6.75	0	1	1	1	9.75
14	3.00	0	1	1	1	6.00
15	5.95	0	1	1	3	10.95
16	3.95	0	1	1	3	8.95
17	3.75	0	1	1	3	8.75

ÖBW = ecotop building function
RL = number of species from the red list
G = degree of potential danger
P = Present value
E = cycle of development
NSW = nature conservation function

2 = mesophytic deciduous and mixed forest
3 = dry groves, bushy assotiation
4 = swamp and marsh woods
5 = humid groves
6 = planted forest pinery
7 = planted decidous woods
8 = young, planted decidous woods
9 = planted mixed woods
10 = bushy assotiation
11 = assotiations of eutriphic waters and springs
12 = assotiation of calciphilous meadow
13 = perennial rudeal and weedy meadow
14 = croplands
15 = little orchards, parks and sportfield
16 = fruit trees
17 = vineyards and hop plantations

Its very low in and around settlements and croplands. The patches under human influence wedge into natural or quasi-natural associationsin the east and west. Thus they decrease the potential renewal and help uniformization.

In the forthcoming part of this study the evaluation of the species of a beech wood, an oak-hornbeam grove, a pusta-grassy slope, an alder marsh, a riverside highweed and a clearing meadow association is presented, on the basis of their temperature budget (T), water budget (W), soil reaction (R) and nitrogene indication (N). The above ecologocal indicators describe the growing site's potential or its change. The letters preceding the names of the species indicate their domestic categories classified by their nature conservation value (see in Simon T. 1988).

Species of beech woods

	T	W	R	N
E Fagus silvatica	5	5	4	2-3
K Lusula albida	5	4	2	2
K Asperula odorata	5	5	3	2-3
K Crataegus oxycantha	5	5	3	2
K Sorbus torminális	5	4	4	2-3
K Campanula persicif	5	4	3	2
K Dyopterys filix-mas	5	7	3	2-3
TZ Lapsana communis	5	4	3	3-4
K Oxalis acetosella	5	7	3	2-3
K Viola silvestris	5	5	3	2-3
K Galium silvaticum	5	6	3	2
TZ Atropa belladonna	5	5	3	4-5
TZ Hypericum perforatum	5	3	0	2-3

Species of oak-hornbeam groves

	T	W	R	N
E Carpinus betulus	5	5	3	2-4
TZ Salix caprea	5	5	4	0
K Tilia cordata	5	5	3	3
K Silene cucubalus	5	4	3	2
K Campanula persicifolia	5	4	3	2
K Galium schultesi	5	4	3	2
K Campanula trachelium	5	6	3	3-4
E Quercus robur	5	6	0	2-3
TZ Hypericum perforatum	5	3	0	2-3
K Euonymus verrucosus	5	4	4	3
K Corylus avellana	5	5	3	2-3
E Quercus cerris	5	3	3	2-3
TZ Campanula ranunculus	7	3	3	2
K Anthericum ramosum	5	3	4	2-3
K Trifolium rubens	5	3	4	2
TZ Scabiosa ochroleuca	6	2	4	1-2
TZ Lotus corniculatus	5	4	0	2-3
TZ Populus tremula	3	4	2	2-3
K Cornus sanquinea	5	4	4	3

Species of rocky grasslands

	T	W	R	N
K Festuca ovinae	5	4	2	1-2
TZ Dianthus armeria	5	3	3	2
K Trifolium pratense	5	6	3	2-3
TZ Centaureum minus	5	5	3	2-3
TZ Achillea millefolium	5	3	0	2-3
K Coronilla varia	4	3	5	1-2
GY Agropyron repens	5	3	0	4
K Galium verum	5	3	4	1-2
K Centaurea triumfetti	5	2	5	2
V Prunella vilgaris	0	6	0	0
GY Inula britannica	5	6	0	3
TZ Ranunculus acer	5	7	0	3
TZ Eryngium campestre	7	2	4	0
GY Euphorbia cyperissias	5	3	0	2
K Thymus glabrescens	5	2	4	1-2
K Briza media	5	6	0	1-2
GY Convolvulus arvensis	0	3	0	0
TZ Plantago media	5	5	0	2-3
K Dorychnium herbaceum	6	3	4	2
TZ Anthyllis vulneraria	5	4	4	2
GY Ononis spinosa	5	3	0	3
GY Cichorium intibus	5	4	0	3-4
GY Dipsacus laciniatus	7	8	4	3
Gy Cirsium arvense	5	4	0	3-4
K Thymus marschallianus	6	2	4	1
TZ Agrimonia eupatoria	5	3	3	3

Species of pusta-grassy slopes

	T	W	R	N
K Chrysanthemum vulgare	5	7	0	3
K Galium verum	5	3	4	1-2
K Knautia drymeia	5	6	3	2-3
K Knautia arvensis	5	3	4	2
TZ Achillea millefolium	5	3	0	2-3
K Centaurium minus	5	5	3	2-3
TZ Agrimonia eupetoria	5	3	3	3
GY Plantago major	5	7	0	3
TZ Dactylis glomerata	5	6	4	3
K Primula veris	5	3	5	2
GY Lathyrus tuberosus	7	3	4	2
K Campanula trachelium	5	6	3	3-4
K Briza media	5	6	0	1-2
GY Equisetum arvense	3	8	0	- -
K Cytisus nigricans	6	4	2	1-2
TZ Anthyllis vulneraria	5	4	4	2
K Melampyrum nemorosum	5	5	3	2-3
K Betonica officinalis	5	3	0	2

Species of the alder marsh in Lake Fekete

	T	W	R	N
K Mycelis muralis	5	5	3	3
E Alnus glutinosa	6	10	0	2-3
K Corylus avellana	5	5	3	2-3
GY Euphorbia cyparissias	5	3	0	2
K Astragalus glyciphyllos	5	5	4	2
TZ Eupaatorium cannabium	5	9	5	2
K Dentaria bulbiphera	5	5	4	3
K Aegopodium podagraria	5	7	3	4
K Galium Schultesi	5	4	3	2
K Asperula odorata	5	5	3	2-3
K Impatiens noli-tangere	5	6	4	3-4
K Acer pseudoplatanus	5	6	3	3-4
K Oxalis acetosella	5	7	3	2-3
K Sorbus acuparia	4	5	2	2
K Campanula persicifolia	5	4	3	2
K Viola mirabilis	5	5	4	0
GY Echium vulgare	6	3	0	0
TZ Prunella vulgaris	0	6	0	0
K Trifolium aureum	5	3	0	1-2
TZ Hypericum perforatum	5	3	0	2-3
TZ Salix caprea	5	5	4	0
TZ Dactylis glomerata	5	6	4	3
K Campanula trachelium	5	6	3	3-4
GY Senecio viscossus	4	6	3	-
K Ribes uva-orispa	5	6	5	3
TZ Solanum dulcamara	5	9	4	3-4
K Stachys silvatica	5	6	3	3-4
Gy Dryopteris filix-mas	5	7	3	2-3

Species of riverside highweed associations

	T	W	R	N
GY Sambucus ebulus	5	5	3	4
TZ Saponaria officinalis	5	4	0	2-3
GY Lamium purpureum	0	5	0	3-4
K Heracleum spondylium	5	6	3	2
K Aegopodium podagraria	5	7	3	4
GY Artemisia vulgaris	5	4	0	3-4
GY Artium lappa	5	6	4	5
E Phragmites communis	0	10	4	2-3
TZ Urtica dioica	5	5	4	4-5
GY Sambucus nigra	5	5	3	4-5
K Calystegia sepium	5	9	4	4
GY Conicum maculatum	5	5	3	4-5
TZ Vicia cracca	5	4	3	0
TZ Dactylis glomerata	5	6	4	3
GY Melandrium album	5	4	0	3-4
K Mentha longifolia	5	9	4	3-4
K Clematis vitalba	5	5	3	3-4
TZ Rubus idaeus	5	5	3	4
TZ Humulus lupulus	5	7	0	3-4
TZ Sisymbrium strichtissimum	4	5	4	3-4

Species of clearing meadows

	T	W	R	N
K Rumex sanquineus	5	7	4	3-4
GY Galeopsis tetrachit	5	4	2	3-4
K Senecio jacobea	6	4	4	2-3
GY Inula britannica	5	6	0	3
GY Matricaria maritima	5	6	1	3-4
TZ Rubus idaeus	5	5	3	4
TZ Rubus caesius	5	8	4	5
TZ Urtica dioica	5	5	4	4-5
TZ Hipericum perforatum	5	3	0	2-3
K Mentha longifolia	5	9	4	3-4
GY Erigeron canadensis	0	4	0	3
TZ Prunella vulgaris	0	6	0	0
TZ Scrophularia nodosa	5	6	3	3
TZ Linaria vulgaris	5	3	3	3
TZ Vicia cracca	5	4	3	0
K Tripholium hybridum	5	8	4	2-3
GY Cirsium arvense	5	4	0	3-4

The beech woods and the oak-hornbeam groves are natural associations among the above ones and the alder marsh is a natural aquatic one. The pusta-grassy slope and the rocky grassland are quasi-natural associations. The riverside highweed and the clearing meadow associations are highly disturbed. Knowing the species of the associations, their ecological indicators were examined on the basis of their temperature and water budgets, their soil reaction and nitrogene demand (after Zólyomi B. 1966).

Kovács M (1975) examined the connection between soils and vegetation in the Mátra Mts, and evaluated the growing site conditions of the characteristic forest types, using TWR values. It was found that T value was 5.09-5.03 in the zonal Turkey oak-oak-hornbeam groves in the north of the Mátra Mts. These values meet the temperature demand of the deciduous woods of the subcontinental-Atlantic climate. This value is somewhat lower with the grassy and hygrophytic association that can be due to micro and mesoclimatic features here.

From among the (10) categories of ***temperature budget indicators***, the values of the batural and quasi-natural associations range between 4.8-5.0, showing the demands meeting the endowments. The indicator value of the strongly degraded highweed association and the clearing meadow is below 4.5, showing the change due to human effects or the above mentioned microclimatic features.

With the ***water budget indicators*** the differences springing from morphology can be felt (0 is for extremely dry environment, while 10 is for humid). The indicator values of the species stand for temperate fresh, fresh and temperate humid growing sites.

The ***values of soil reaction*** represent slightly acid and almost neutral soils that is in harmony with the properties of rankers, mull-rankers and brown forest soils having been formed on the volcanic parent rock and on its products accumulated in the valleys.

The ***nitrogene indicator*** is the highest in the riverside wetlands and in the clearing meadows. The forests have a medium nitrogene indication, while the psuta-grassy slopes have the lowest values.

The weed and disturbance resistant species of the natural and quasi-natural associations are left out of the average calculation in the next table:

	T	W	R	N
Beeches	5,00	5,20	3,1	2,25
Oak-hornbeam	5,00	4,35	3,14	3,85
Rocky grass	4,60	3,70	3,10	1,56
Pusta-grassy slope	5,09	4,36	2,46	2,22
Alder marsh	5,00	5,55	2,94	2,87

The values, apart from a few exeptions, are higher than the formerly calculated averages. The species of the ***natural associations prefer the humid, almost neutral and nitrogene abundant environment.*** The rocky grass, developing on shallow, nitrogene-poor soil is the only exeption.

There are only few species belonging to the natural associations among the very much disturbed riverside highweed associations and the clearing meadows. Average calculation was limited to only a few species occurring in natural associations, but the tendency remained the sae as above. The difference was manifested here with the water budget and soil reaction indicators.

	T	W	R	N
Riverside highweed association	4,16	7,66	3,50	3,22
Clearing meadow	5,25	7,001	4,00	3,00

After comparing the demands of disturbance and weed resistant species to the previous ones:

	T	W	R	N
Riverside highweed association	4,57	5,20	2,21	3,60
Clearing meadow	4,23	4,92	1,76	3,10

In the first case the high demands for water and for favourable chemical reaction are manifested with the species building up natural associations. In the second case, where only the species inducing disturbances are considered, the low indicator figures of water budget and soil reaction are due to environmental damages. It is so, especially the riverside association is neighbouring agricultural lands, while the clearing meadow is an assotiation occurring after clear-felling, giving way to the disturbance resistant species to spread.

Defining the degree of harmful human effects or naturality is not always enough in ecological evaluation as it can be concluded from the above. Analysing evaluation wants the description of detailed ecological demands too.

Considering the above, the water budget and the soil reactions are the subjects of further investigation from among the ecological indicators. From the relative distribution of W and R values for the five associations (as shown in Figure 3), the beech wood is found to consist of species having the same level of water and soil reaction demands. There is only one plant, the disturbance resistant Hypericum perforatum, having different demands. The demands of the species of the hornbeam - oak grove are similar, though the values range a bit wider than with the beech.

More than one third of the species of the pusta-grassy slope and the riverside highweed association have different water demands and the soil reaction quality is not essential for them. Also, the highweed association and the clearing meadow have quite different water demands. All these verify the latter associations needing no special ecological endowments and their being capable to accomodate themselves to the changing environment.

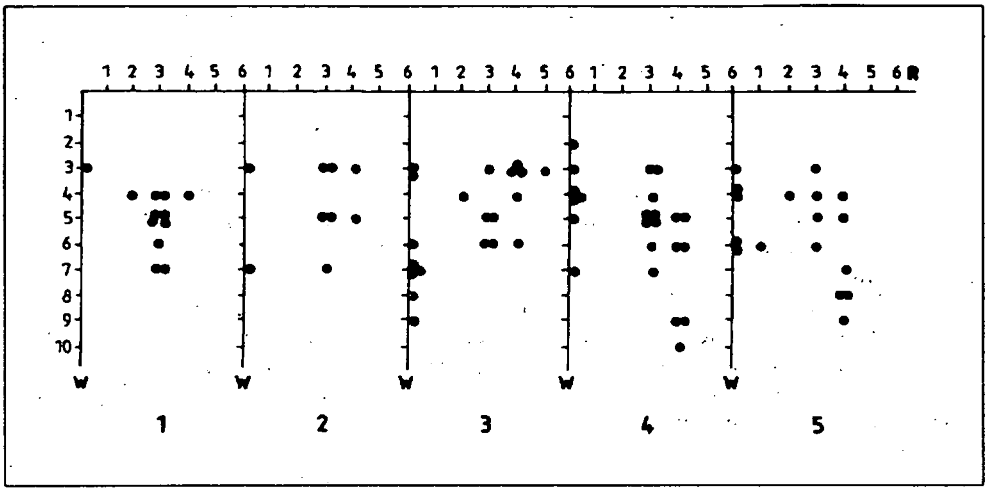

Figure 3 *Ecological indicators of water budget (W) and soil reaction (R) of a few characteristic associations in the catchment area*

Simon T. (1992) assigned rank scores to the species of Hungarian endemic vascular plants according to their nature conservation value. In his classification there are ten groups of species: native, subendemic, relic or unique (U), strongly protected (KV), protected (V), natural dominating (E), natural adjacent (K), natural pioneer (TP), disturbance resistant, natural (TZ), adventive or neophytic (A), weed (Gy). While the first six groups represent the naturality of the associations, the last four stand for the different degrees of degradation.

On the basis of the above groupping, Figure 4 shows the nature conservation value diagram of the natural and secondary associations. In the investigated associations there are very few unique, protected, or strongly protected species. The number of natural adjacent species is, however, very large (included in the dotted columns of the diagram representing the natural associations). The disturbance resistant species and weeds are increasing in the associations under human impact. Figure 4 also displays the woody associations of high stability reducing the weeds. On the other hand, if they are clear-felled only a very few association-building natural species are to be left and the degradation replaces development. Agricultural overuse may also result in degradation. The large number of weed and disturbance resistant species emerging into the riverside highweed association may be an example of the above.

Conclusions

The intensified ***protection of the mixed deciduous and mesphylic woods*** in the catchment ought to be declared. In the test area, several patches of beech and oak groves are being shrunk and slowly disappearing with degradation signing associations emerging into their place.

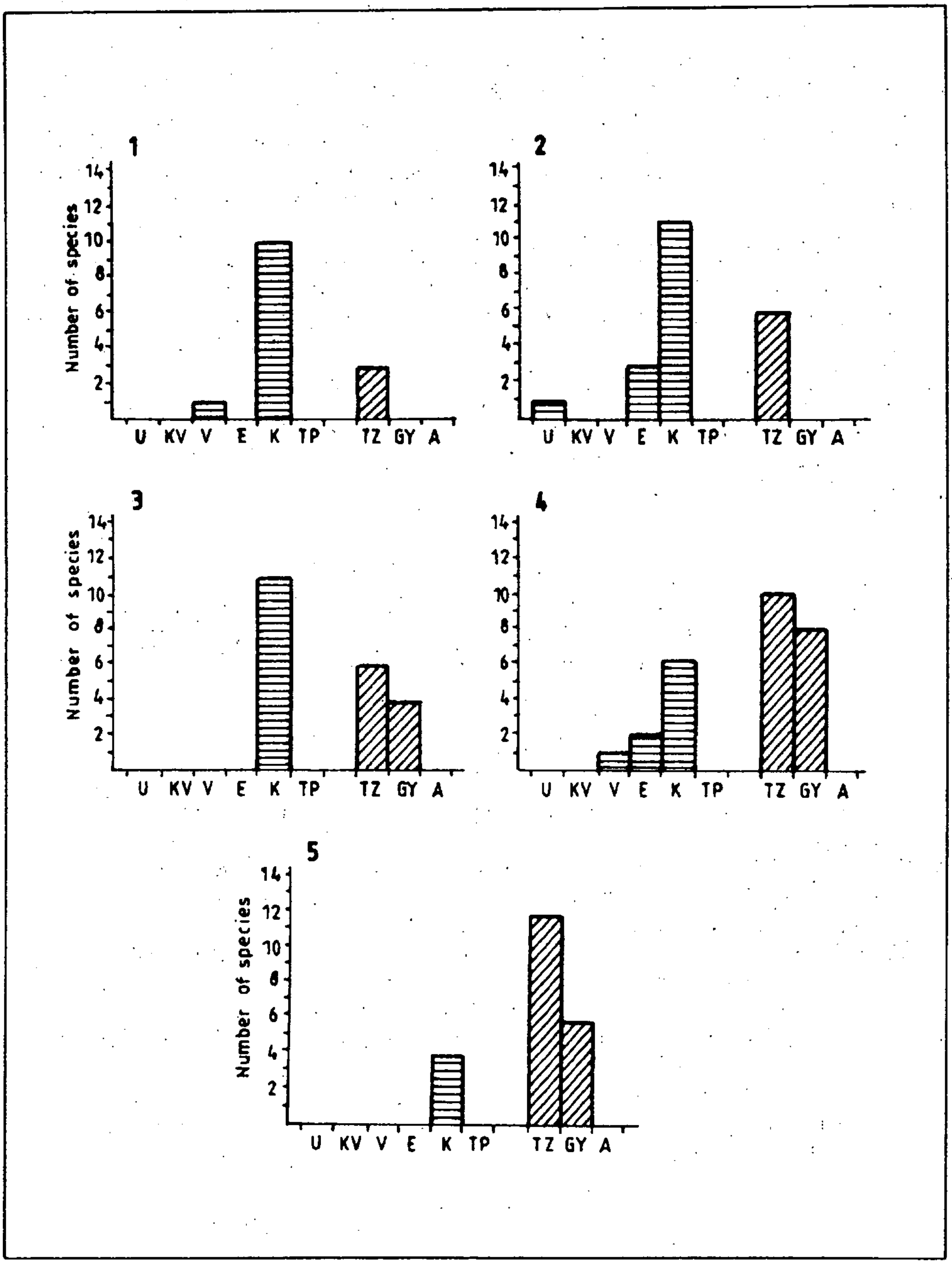

Figure 4 *Nature conservation value diagram of some natural and secondary associations in the test area (using the classification of Simon T.)*

Intensive land cultivation is not possible on the relatively very rough surface of the test area. A ***buffer zone*** ought to be outlined around the lesser spots and along the cultivated lands. The width of the zone should depend on the stability of the associations in order to slow down degradation. The ***dry groves, bushes and pusta-grassy patches*** have already played the role of the buffer zone at some places. The pusta-grassy patches, however, occupy too large territory and their ecotop-building function is low, and they are in the degrading stage or at least in the initial one. A part of the dry pusta grass (where the terrain is not so rough), is ***suitable for cultivation***. They have to be divided from the natural or quasi-natural associations with a couple of ten or a hundred metres wide buffer strips.

Summing it up: the territory of the Katarét Brook catchment has undergone a change due to human impact. Natural and quasi-natural associations have survived first of all on the relatively rough surfaces. ***Intensive agricultural land use made ecological endowments change and that is reflected in the rather low values of biotop-building and nature conservation functions***. The nature conservation diagrams of the different associations also sign this process. Disturbance resistant and weed species occur in large number in the associations. The above conclusions contribute to the complex geoecological evaluation of the area and to find optimum land use.

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References

KOVÁCS, M(1975). Beziehung zwischen Vegetation und Boden. Akadémiai Kiadó.p.365.

MARKS, R.,MÜLLER, M.J.,LESER, H., und KLINK, H.J.(1989). Anleitung zur Bewertung des Landschaftshaushaltes. Zentralausschuss für deutsche Landeskunde, Selbstverlag,5500.Trier. p.164.

MEZŐSI, G.- KEVEI - BÁRÁNY, I. - BALOGH, I. - MUCSI, L. - T.FARSANG, A. (1993). A geoökológia és a geoökológiai térképezés néhány elvi és gyakorlati kérdése. Földrajzi közleménzek CXVII.kötet,3.sz.pp.163-176.

SIMON, T. (1992). A magyaroszági edényes flóra határozója.Harasztok és virágos növények.Tankönyvkiadó. p.892.

ZÓLYOMI, B. (1966). Einreichung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR Zahlen. fragmenta Botanica Musei Historico-Naturalis. Tom. IV:Fasc.1-4. pp.101-142.

ACTA Geographica Szegediensis Tomus XXXV. 1994-95. pp 65-79.

REGIONAL ANALYSIS OF THE HEAVY METAL CONTENT OF SOILS ON THE NE-PEDIMENTS OF THE MÁTRA MTS.[1]

Andrea Farsang

Introduction

Although metals including heavy metals are natural compounds of our environment, the atmosphere, pedosphere and hydrosphere, according to some predictions they seem to be major polluting agents in the decades to come. Owing to the effects of different physical, biological and chemical parametres (like reaction, temperature or land use changes, heavy metals can be remobilized and re-accumulated at certain spots exceeding health limits (Reiche 1992, Fillus, Richter 1991). Human activity (agricultural fertilizers, manure, communal waste, metal foundries, air pollution from chemical factories, lead emission of motor traffic etc. all contribute to heavy metal accumulation. The above reasons recommend their detailed investigation and the definition of their role in landscape development.

In this study the areal distribution of metal ions and its regularities manifested are being surveyed in the heterogenious soil of a physical geographical unit (a catchment area) having various economic land use classes (forest, agriculture, mining). In the first stage of the survey to reveal landscape links the relations of these important, environmental-reflexive elements were studied with other measurable soil or morphological parametres. The measured values were then compared both with the European average and the health limits.

Geographical outlining of the test area

A hydrogeographically unified, but geologically, morphologically versatile surface with various land use types was chosen for detailed survey of landscape factors. The area is situated in the NE of the Mátra Mts in the Mátra Foothill and Parád--Recsk Basin microregions (Figure 1). The central settlement of the approximately 6 km long and 3-5 km wide catchment is Bodony. The boundary of the test area is represented by the dividing line marking the Kataréti Brook's and Áldozó Brook's catchment (Figure 2).

The area is elevated to 200-880 m above sea level. It is a low hilly region or infrabasin hills, sloping mainly to N-NE, The average watercourse density of its erosionally and derasionally dissected surface is 4.2-4.7.

[1] The survey was performered in F4016 OTKA project

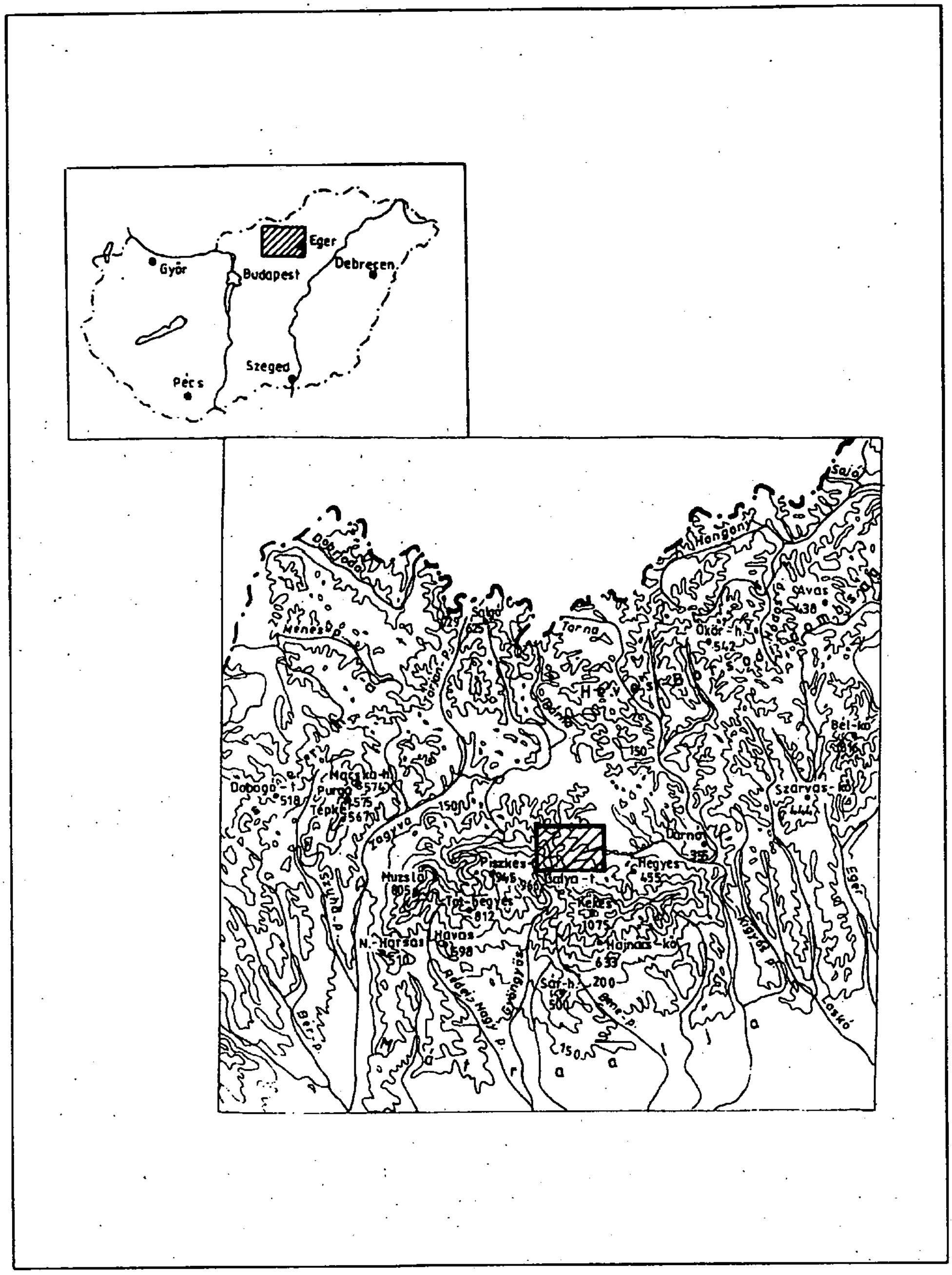

Figure 1 *Location of the test area*

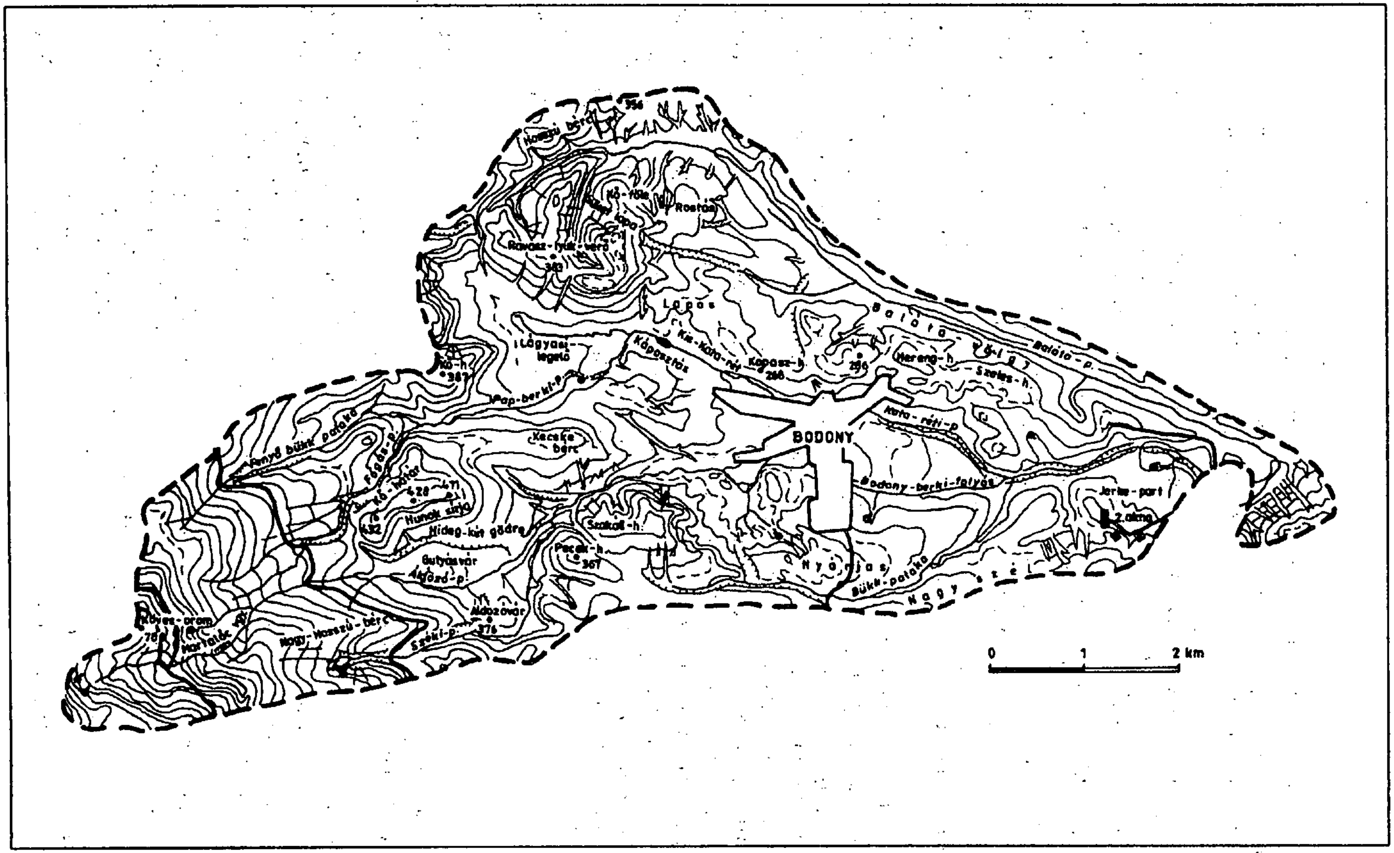

Figure 2 *Topographic map of the test area*

Geologically it has a double character. The geological structure of the region is manifested on the surface in Upper Eocene andesite and dacite and their tuffites. The parts in the basin are covered with Middle Oligocene clay, clay marl and schlieren (Figure 3).

Its climate is temperately cool and humid. The annual mean temperature is 8.3-8.5. °C and the number of sunshine hours is about 1900. The annual average precipitation is 650-750 mm. Its climate and endowments favour sylcanoculture, but also agriculture if less temperature dependent species are concerned.

Its soil is clayey brown forest soil (95 %) developed partly on andesite and andesite tuffite detritus, partly on Tertiary sediments. Its mechanical composition is loam and clayey loam. Soils have neutral or weak acid reaction and the W-SW, forested slopes have definite acid reaction. In the brooks' valleys there are young, raw alluvial soils with clayey composition and acid reaction.

From land use point, the catchment has again a double character: its W-SW part is forested (Turkey oak and oak, sessile oak and hornbeam), its E part is cultivated (croplands mainly).

Sampling and methods of analysis

More than 150 soil samples were taken from some 20 km^2 large area in the summer of 1992. Soil profiles were sampled by 25 cm down to 150-200 cm in the area covered with Tertiary sediments. In the rougher W-SW areas, samples were taken down to the parent rock that is only 30-40 cm at places. Considering the heterogenity of the area, samples were taken relatively densely and evenly. There was no sampling within the settlement limits, in private orchards and in the non-trespassing area of the Recsk Copper Mines on and around Lahóca Hill. Sampling sites are about 200-400 m from one another. The heavy metal content, reaction and hydrolytic acidity tests were performed on samples from 30-40 cm depth. The vertical heavy metal tests of soil profiles (Frühauf 1992) are suitable to detect the metal content of lithogenic origin and that of deposited from human-technical impact, if the samples are from this depth. There were 128 samples analyzed. (Figure 4)

Chemical reaction (H_2O) was measured by an electric pH meter, while hydrolytic acidity (Y_1 value) was defined by volumetric analysis with phenoltalein indicator in calcium acetate solution. Metal content of the soil was detected for 9 elements (Al, Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn). Selection of elements is defined by several factors. Having considered the dominant rock type of the area (andesite), metals from that had to be measured (Cd, Cu, Ni, Zn). Iron, mangane, aluminium oxides of the soil do influence the occurrance and affinity of the heavy metals. Pb and Cd were measured due to possible human impact. The values of microelement content were obtained through JY-24 type spectroscopic analysis of 1 g soil sample after the hydration approach with recirculating drip refrigerator.

Samples having deviated from the average were taken out of further analysis after the distribution analysis of the parametres (Al, Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn, pH, hydrolytic acidity). Their control measurement was to be performed seperately.

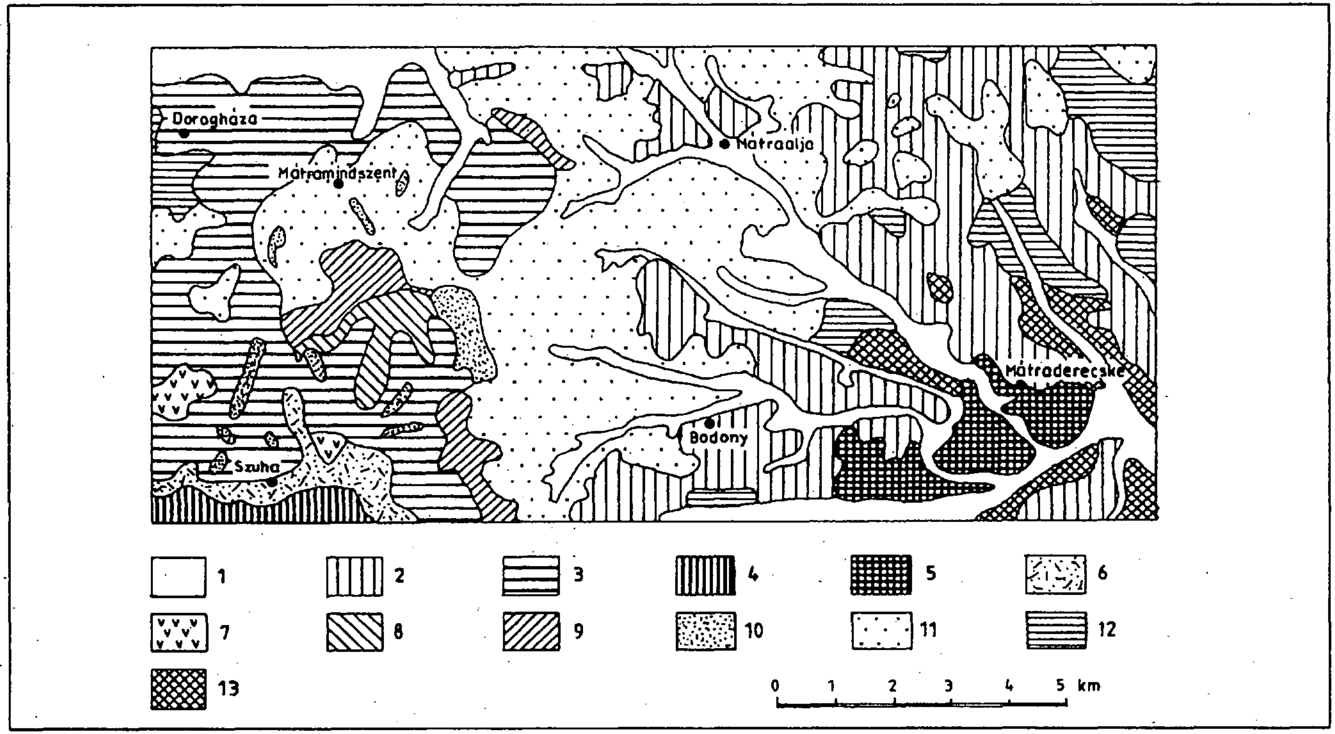

Figure 3 *Geological map of the test area*

1=Holocene in general 2=Pleistocene in general 3=slope clay 4=various andesite beds 5=pyroxene andesite 6=middle rhyolite tuff 7=andesite, lava flow. laccolith 8=direct cover of beds with brown coal layers 9=lower rhyolite tuff 10=sand, gravel, variegated clay 11=sand, sandstone 12=grey sandy clay 13=foraminiferal clay marl

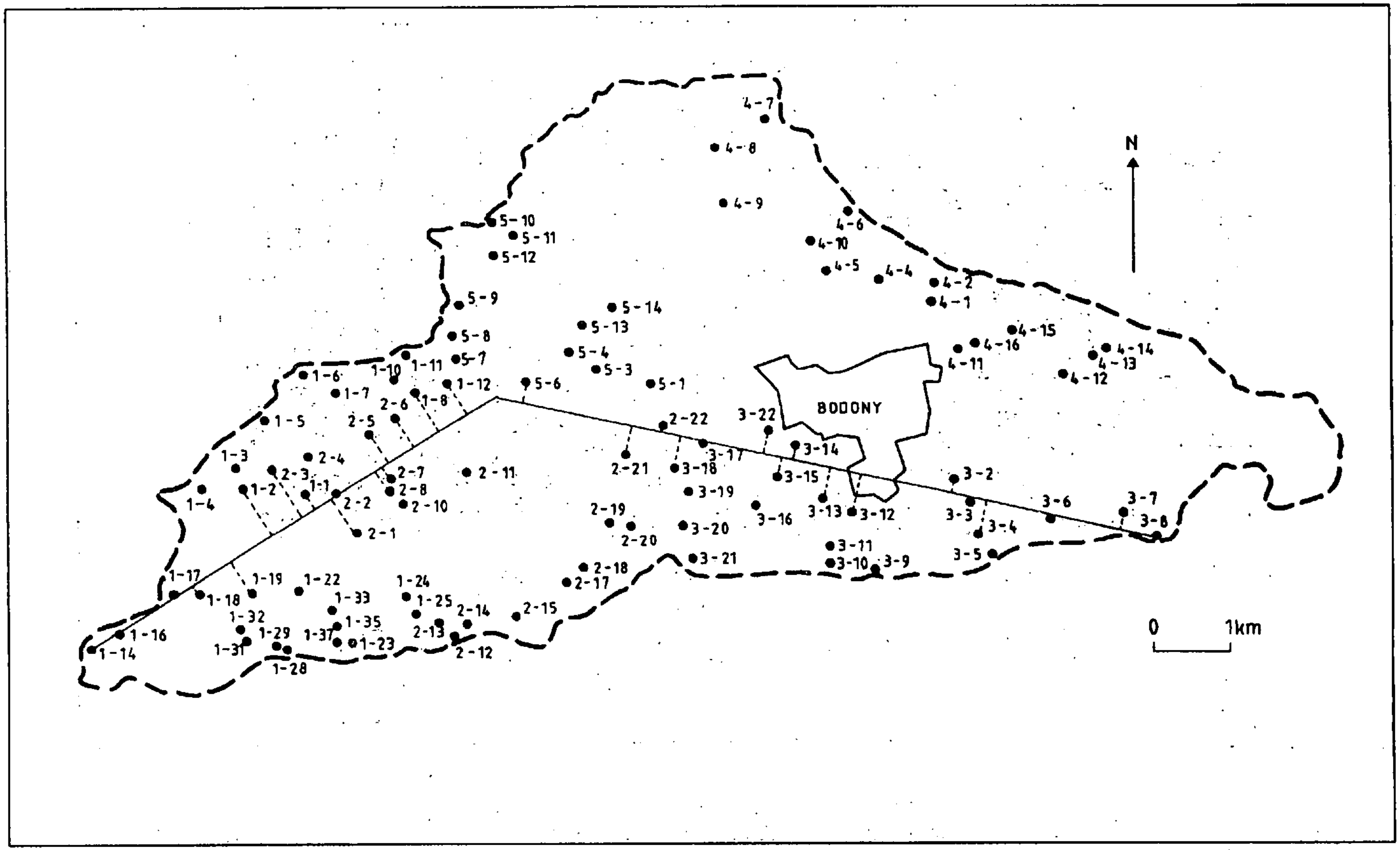

Figure 4 *Sampling sites in the test area*

Evaluation of results

In surveying the relations among landscape factors, the relations of the compounds of the geofactors also have to be examined in detail today. So far the metal content of soil has been investigated from the viewpoint of their biological role. The main natural and human sources of trace elements filtering into soil are known (Papp 1983). Also, the global biochemical circulation of the metals is known (Papp, Kümmel 1992). However, the spatial distribution of these elements have also to be examined. What are the relations to be found between them and between other areal factors liable to undergo changes?

The average values of the metal content of soils on the basis of the samples collected from the test area are the following in ppm: Al - 22246, Cd - 2.2, Co - 9.9, Cu - 14.2, Fe - 25441, Mn - 899, Ni - 26, Pb - 17, Zn - 61. These values are similar to the ones occurring in an area having no or very moderate human impact (Brümmer et al 1991; e.g. Cu: 2-40 ppm, Ni: 5-50 ppm, Pb: 2-60 ppm and Zn: 10-80 ppm). In case of cadmium, however, this average value is 0.1-0.6 ppm. In the test area it is several times higher (2.2 as in Figure 5), being very close to health limit (3 ppm in Brümmer et al 1991). The volume of cadmium in the polluted soils is determined first of all by the parent rock. From human impact two thirds of Cd can be emitted into the atmosphere through the metallurgy of precious metals (zinc and copper). From the air it is deposited dry onto the soil (Mészáros et al 1993). Waste burning and the producion of phosphate fertilizers are another source of Cd. The samples taken from the test area, however, do not allow human impact, because the correlation between Zn and Cd is strong (0.69 coefficient) that shows a significant relation on the 0.001 level. This strong, almost linear correlation can be seen easily in the Cd-Zn diagram too (Figure 6). The enrichment of Zn is known in the test area and it had been mined for years. This high value of Cd ought to be due to the parent rock therefore.

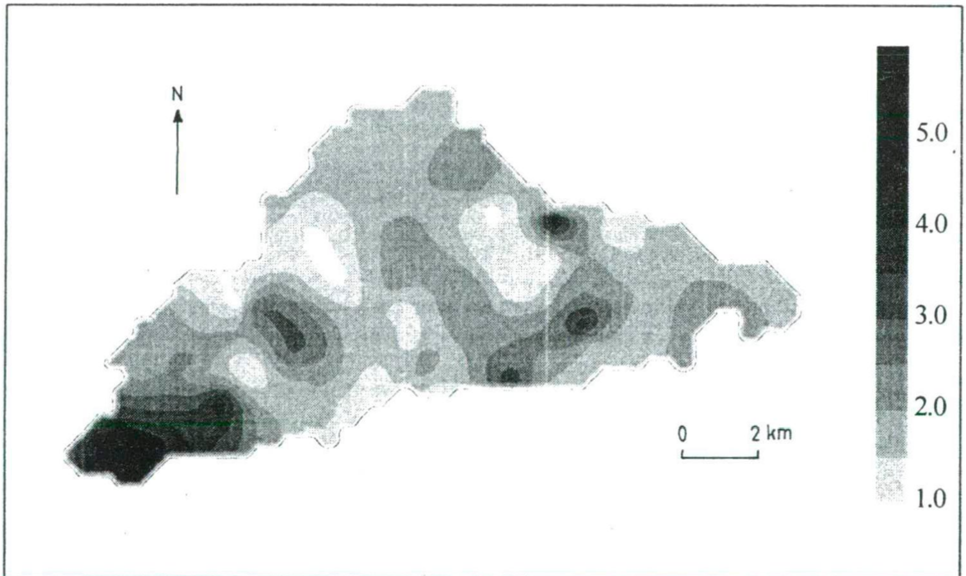

Figure 5 *Regional distribution of Cd content of soils (ppm)*

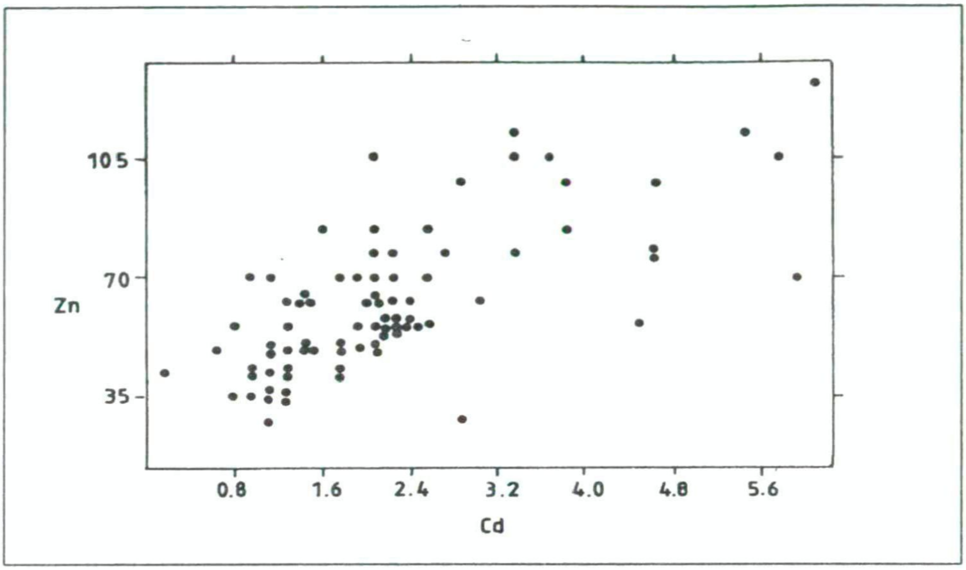

Figure 6 *Zn - Cd diagram (values in ppm)*

Cd compounds have a toxic effect on the haematotherma. They can easily reach man at the end of the food-chain and their threshold values for human health are very low, This enrichment of this element has to be the objective of further investigations.

The spatial distribution of metal contents are shown in Figures 5 and 7-9. Having compared them with the elevation contour line map of the area, their relation with elevation is easy to be seen. It is also proved by the strong correlation between the soil sampling sites' elevation above sea level and the metal concentration levels. (With the exception of copper, all metal concentrations show a significant correlation of 0.001 level with the elevation; see Figures 10-11). It can be explained by a third factor, the parent rock that cannot be described numerically. In the active valleys, the metal content was found to be lower than towards the water divide on the combs. It is especially well-marked in the SW of the test area, where relief energy is the largest (the dividing line is at Galyatető), on the Pecek Hill (367 m) and Kecske Hill (340 m). The soils of the above mentioned sites were formed on andesite or on its tuffs. Here, owing to the greater slope angle, the depth of soil is thinner than elsewhere in the basin (on the slopes of Galyatető it is only 30-40 cm). Moreover, the effect of the parent rock is rather great on lithomorphic soils.

The E part of the test area has more metal content and there are several other factors modifying the relations between parent rock, morphology and metal content. The Jerke part (250 m) outstanding of its surroundings and its parent rock (andesite) have influence on metal concentration. The number 2 shaft of the Recsk Copper Mines, its waste rock pile and a sewage sludge depository can also be found in the test area. They excersise influence on the soil of their immediate environment through the definition of this impact requiring a more detailed sampling.

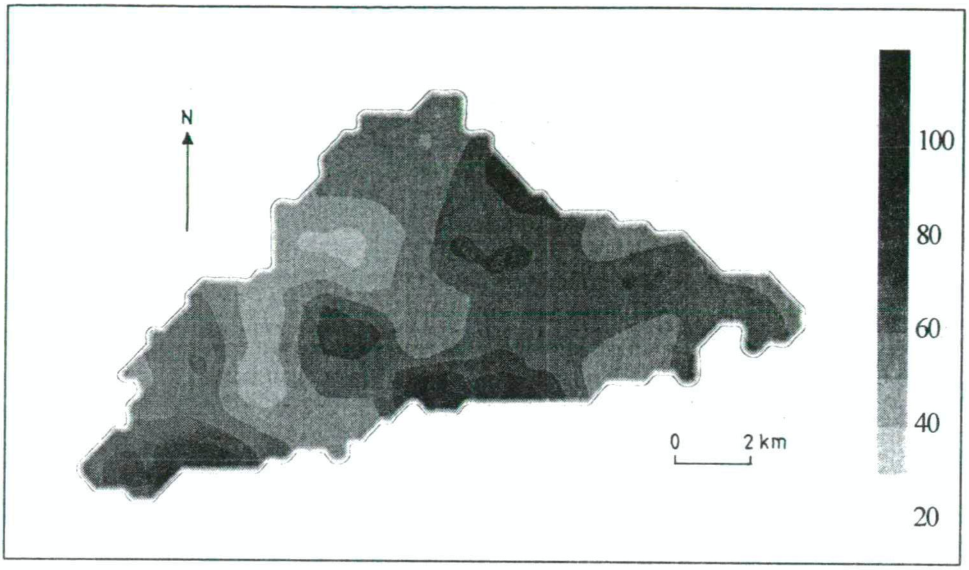

Figure 7 *Regional distribution of Zn content of soils (ppm)*

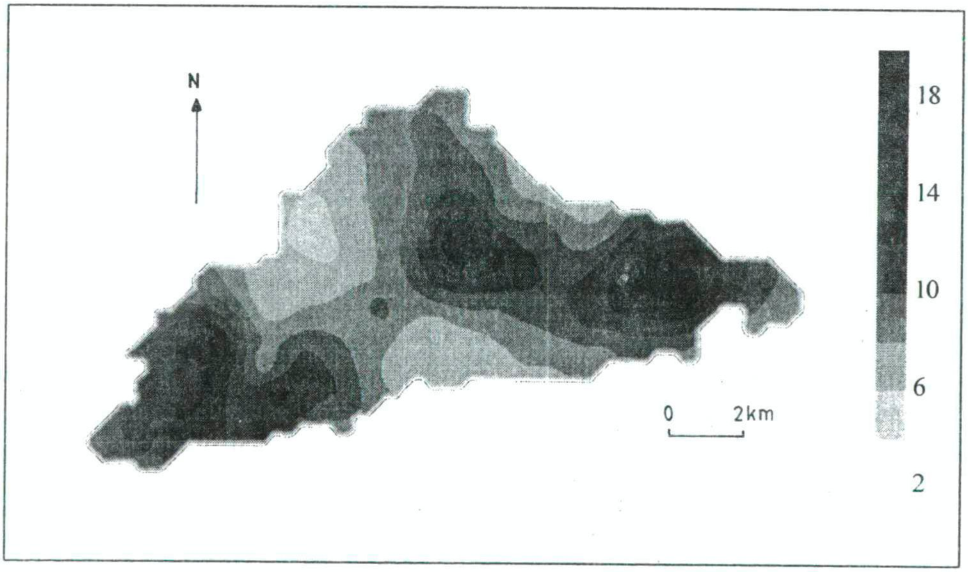

Figure 8 *Regional distribution of Co content of soils (ppm)*

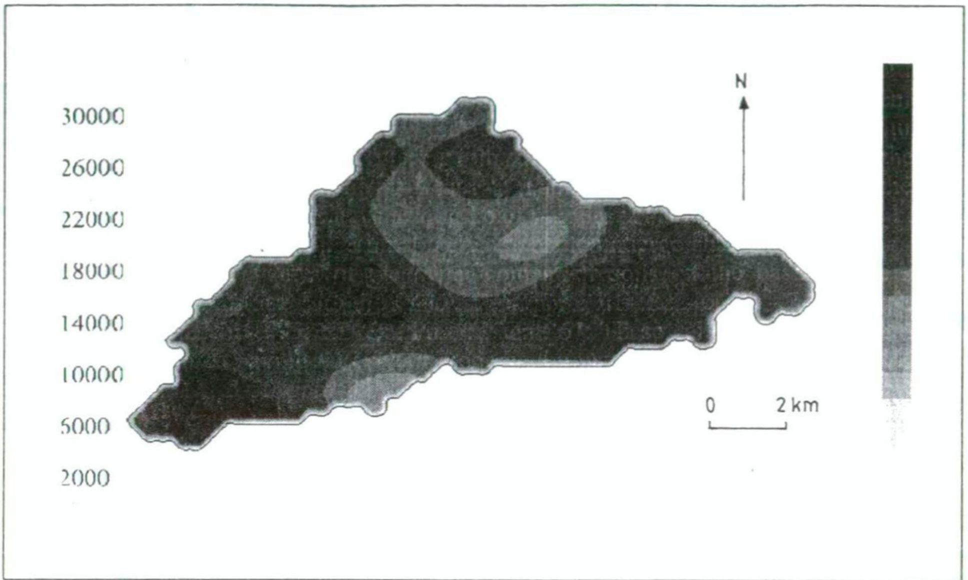

Figure 9 *Regional distribution of Al content of soils (ppm)*

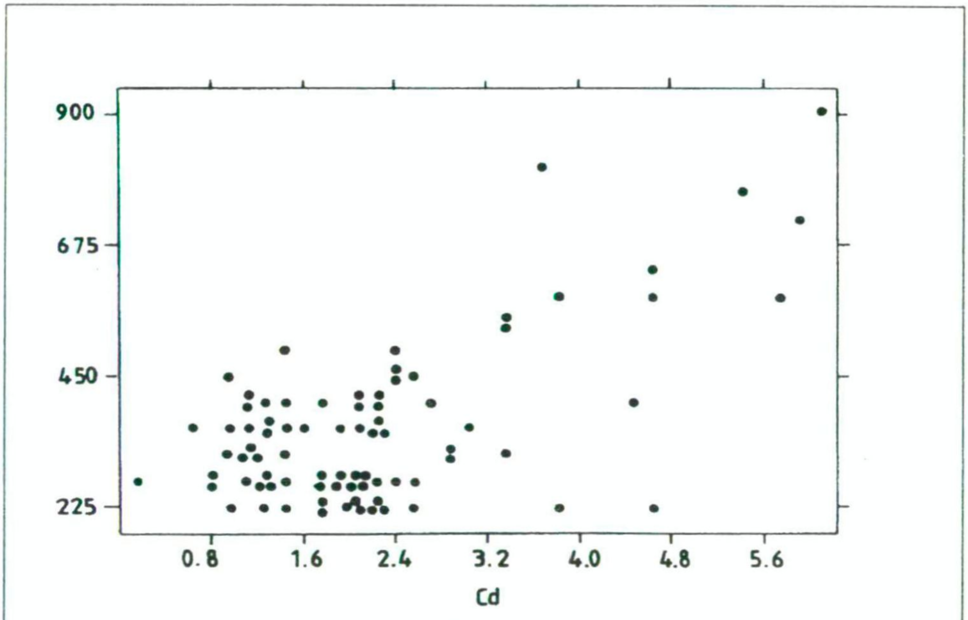

Figure 10 *Elevation (in m) - Cd (in ppm) diagram*

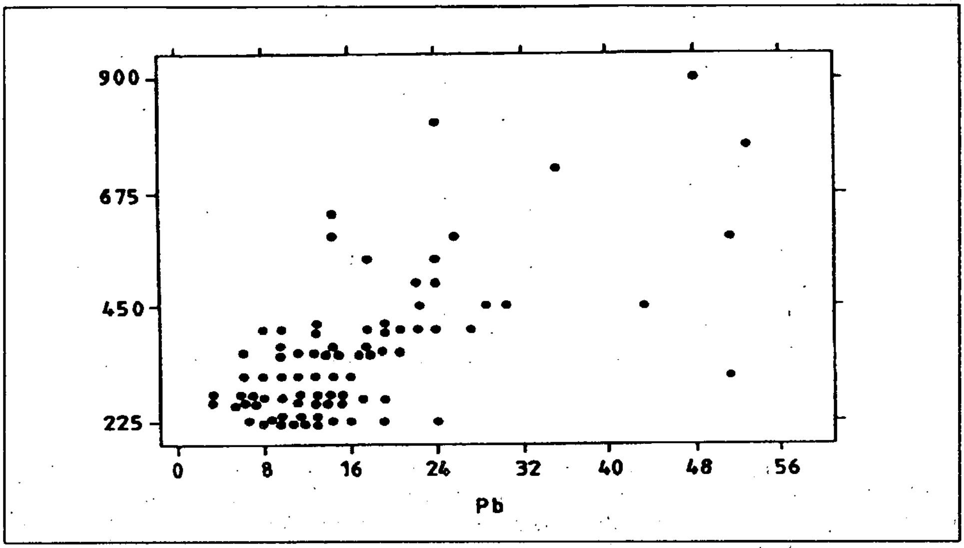

Figure 11 *Elevation - Pb diagram*

The soil reaction also contributes to the metal holding capacity, mobility and metal content of the soil (Vermes et al 1993). Table 1 shows the relation between soil reaction and metal linkage analysed in this research (Leser, Klink 1989). The values of the Table represent soils of low humus content and sandy loamy soils. In case of larger humus content or other mechanical composition these values will be slightly modified. In the test area there are loamy and clayey loamy soils. So now, these values ought not to be modified (Blume, Brümmer 1987 in Leser, Klink 1989). Values describing ion-linkages can be interpreted as below: 0 = none; 1 = very slight; 2 = slight; 3 = medium; 4 = strong; 5 = very strong.

Chemical reaction of the soil can be described another way. Hydrolytic acidity can be defined from the samples collected to analyse their metal content. There was a strong positive correlation found between these values and that of metal concentrations. The relation is also manifested regionally. The reaction of the soil is changing parallel with the elevation contour lines, though it is not enough in itself to have an impact on the spatial distribution of the metals (apart from local deviations), if the above Table is considered, since the dominant reaction values are 5.5-6.5. The mobility increasing chemical reaction of soils occurs at 5.5 pH value, or at greater acidity than that (see Table 1, Brümmer et al 1991).

There is an E-W or NE-SW trend of change of morphological, geological and techno-pollutional values in the area. So the change of metal concentration values is also worth examining in a cross section of similar direction (Figure 4). The relations between heavy metal concentration and geomorphology, and between heavy metal concentration and geology are evident as far as Zn, Pb and Cd are concerned (Figure 12). In their examples, the three peaks of the concentration are connected to the above mentioned geomorphological units, while the sudden rise in the E part represents a transition towards the Lahóca Hill that could not be sampled.

metal	*pH ($CaCl_2$)*									
	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
Cd	0	0-1	1	1-2	2	3	3-4	4	4-5	5
Mn	0	1	1-2	2	3	3-4	4	4-5	5	5
Ni	0	1	1-2	2	3	3-4	4	4-5	5	5
Co	0	1	1-2	2	3	3-4	4	4-5	5	5
Zn	0	1	1-2	2	3	3-4	4	4-5	5	5
Al	1	1-2	2	3	4	4-5	5	5	5	5
Cu	1	1-2	2	3	4	4-5	5	5	5	5
Pb	1	2	3	4	5	5	5	5	5	5
Fe^{3+}	1-2	2-3	3-4	5	5	5	5	5	5	5

Table 1

The last stage of the survey to reveal this connection was a cluster analysis performed to group the ten variables (AL, Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn, hydrolytic acidity). Forming the clusters was done with the farthest neighbour method, observing the Euclidean standard. A simplified dendogram of the clusters is shown in Figure 13. The three major sample groups (A1, A2, B) are clearly seperated in space, mappable (Figure 14) and show a strong correlation with morphology. Table 2 displays the characteristic average values of the groups.

metal	A_1	A_2	A_3
Zn	61.6	45.1	82.6
Cd	2.0	1.17	3.9
Cu	13.8	15.4	13.8
Pb	15.7	13.2	24.1
Co	9.7	6.7	13.9
Ni	28.5	25.1	22.0
Fe	24509.3	14364.8	40588.9
Mn	706.5	1090.9	1132.6
Al	21184.4	14922.4	33327.8
hydrolytic acidity	12.8	12.6	25.1

Table 2

In the cluster map the representative groups answer the major morphological units of the test area. A part of the samples classified into group B is situated on the hillside sloping towards Galyatető, while the other part can be found around the waste rock pile belonging to shaft 2 of the Recsk Copper Mines. The majority of the samples of group A1 can be found in the basin, while that of group A2 in the low hilly region.

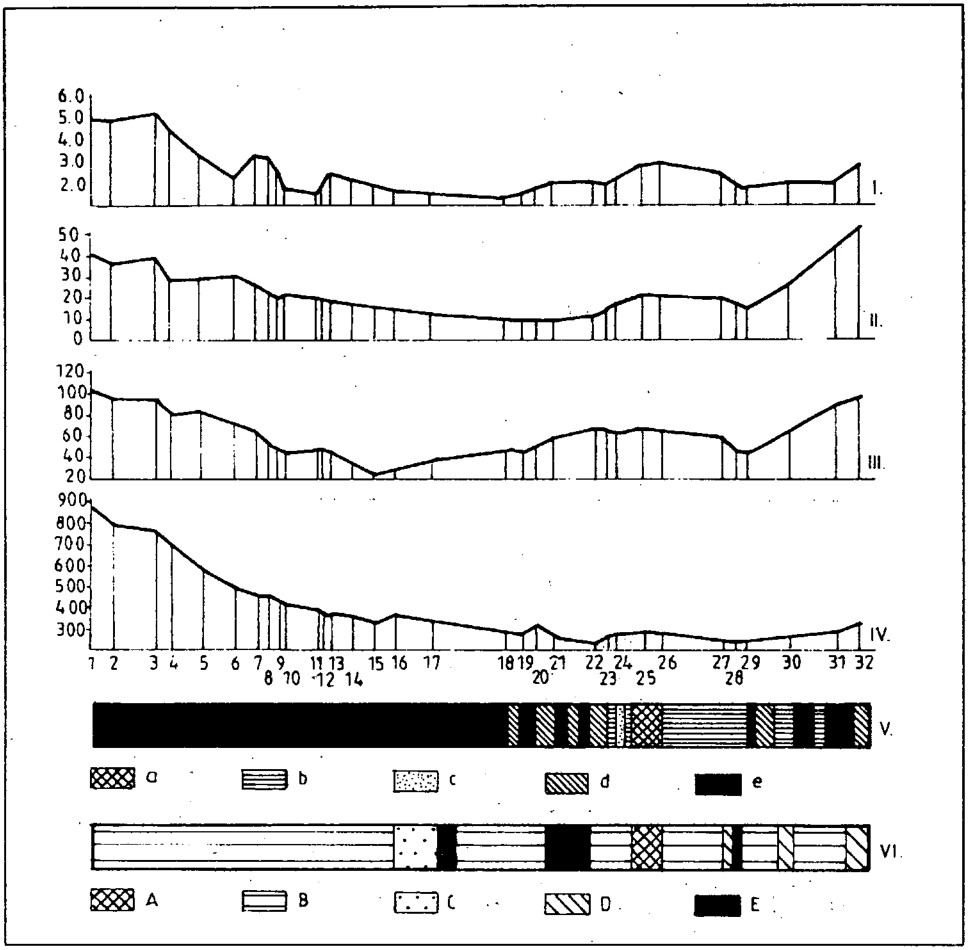

Figure 12 I.- *Cd distribution in the E-W cross section of the test area*
II. *Pb distribution in the E-W cross section of the test area,*
III. *Zn distribution in the E-W cross section of the test area*
IV: E-W section of morphology of the area (y axis=elevation in m),
V: land use in the E-W crossection of the area,
VI: soil types in the E-W section of the area
a=settlement, b=meadow, c=orchard, vineyard, d=pasture, e=forest
A=settlement, B=brown forest soil, C=pseudo gley brown forest soil,
D=rusty brown forest soil , E=humic alluvial soil
sample sites on I-IV.figures:
1=1-14, 2=1-16, 3=1-17, 4=1-18, 5=1-19, 6=1-2, 7=2-3, 8=1-1, 9=2-1, 10=2-2
11=2-8, 12=2-7, 13=2-5, 14=2-6, 15=1-8, 16=1-12, 17=5-6, 18=2-21, 19=2-22,
20=3-18, 21=3-17, 22=3-22, 23=3-15, 24=3-14, 25=3-13, 26=3-12, 27=3-2,
28=3-3, 29=3-4, 30=3-6, 31=3-7, 32=3-8,

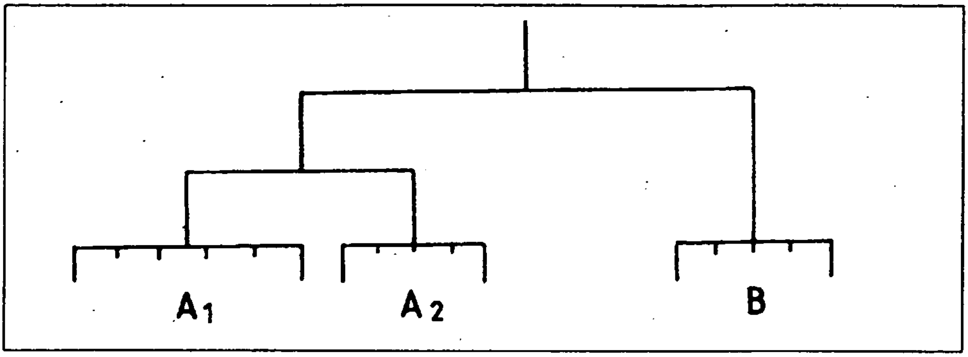

Figure 13 *Simplified diagram of the cluster analysis (on the basis of all variables with Euclidean standard)*

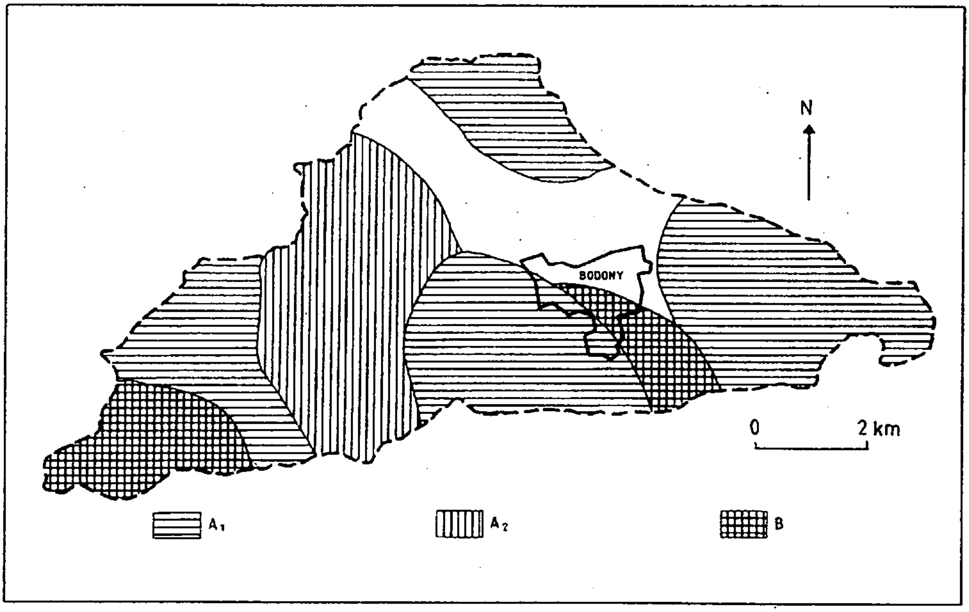

Figure 14 *Cluster map of the test area*

Summary

From among the relations of the landscape factors, the relationships between the metal content of soils and morphology and the chemical reaction of soils have been examined along with their spatial distribution. The results of the above examination reveal the defining role of geological condition (and partly that of the reaction, the humus and clay content of soils) in the regional variability of metal ions of soils. (It is especially true

for the soils of neutral or slightly acid reaction.) Most metal content of soils can be regarded as lithogenic. The relation between the parent rock that cannot be described numerically, and the elevation above sea level is detectable in the test area. It results in the virtual connection between the metal content of soils and the sampling sites' elevation above sea level. A more detailed investigation of the vertical soil profiles from the polluted areas in order to detect the human-technical impact included in their metal content is under way. Similarly further examination is needed to establish the interrelation between the metal content of soils and other landscape factors.

Literature

G.W. BRÜMMER - V. HORNUNG - D.A. HILLER: Schwermetalbelastung von Böden - Mitteilungen Dt. Bodenkundlivhe Gesellschaft 1991/63. pp. 31-42.

H.L. BOHN et al.: Talakémia - Mezőgazdasági Kiadó Budapest 1981. p. 379.

H.J.FIEDLER - H.J. RÖSLER: Spurelemente in der Umwelt Gustav Fischer Verlag Jena, Stuttgart 1993. p.385.

A. FILIUS, J. RICHTER: Desorption und Verlagerung von Schwermetallen in Abhangigkeit von pH-Wert. - Mitteilungen Dt. Bodenkundl. Gesellschaft 1991/66. pp.299-301.

M. FRÜHAUF: Zur Problematik und Methodik der Getrennterfassung geogener und antropogener Schwermetallgehalte in Böden - Geoökodynamik 1992, Band XIII. pp.97-120

R. MARKS, M. J.MÜLLER, H. LESER, H.J.KLINK: Anleitung zur Bewertung des Leistungsvermögen des Landschaftshaushaltes - Zentralausschuss für deutsche Landeskunde, Selbstverlag Trier 1989.

MÉSZÁROS E., MOLNÁR Á., HORVÁTH Zs.: A mikroelemek légköri ülepedése agyarországon - Agrokémia és talajtan 1993/3.-4. pp. 221-228.

PAPP S.: Szervetlen Kémia II. - Tankönyvkiadó Budapest 1983. p.570

PAPP S., R.KÜMMEL: Környezeti kémia - Tankönyvkiadó Budapest 1992. p.359

E.W. REICHE: Regionalisierende Auswertung des Schwermetallkatasters Schlesswig-Holstein auf der Grundlage eines Geographischen Informationssystems Kieler Geographische Schriften 1992, Band 85. pp.42-58.

STEFANOVITS P.: Talajtan Mezõgazdasági Kiadó, Budapest 1981. p.379

VERMES L., PETHÕ E., PETRASOVITS I., CSEKÕ G., MARTH P.: A kadmium elõfordulásának vizsgálata Pest megyében - Agrokémia és talajtan 1993/3.-4. p.229-244

ACTA Geographica Szegediensis Tomus XXXV. 1994-95. pp 81-87.

SURVEY OF THE INTERACTION BETWEEN SOIL AND VEGETATION IN A KARSTECOLOGICAL SYSTEM /AT AGGTELEK, HUNGARY/

Ilona Bárány-Kevei - András Horváth

Introduction

The Aggtelek Karst Region was declared as part of the World Heritage on 2 December 1995. Its surface and subsurface karst formations and its ecology are both worth protecting. Since the formation of the Aggtelek National Park /1985/ the measures taken to limit human activity have brought some predictable improvement in maintaining a state close to the natural conditions. The continuous research of environmental changes undergoing in this region is very important therefore. Dolines are environmentally very sensitive sites of the karst regions /Pfeffer, K.H. 1990/, since a considerable amount of water is seeping through their deepest points into the soil and the rock. The possible harmful materials, running off the slopes laterally with the water, can concentrate there.

The soil and the vegetation of the dolines are the indicators of the changes occurring in the karstecological system, induced by outer effects. These changes are manifested on and in the upper layer of the soil, that is why the survey is focusing on them.

Methods

During the last week of August 1995, soil samples were collected and a plantecological survey was carried out in the Great Doline of Aggtelek /see it in the map of Figure 1/ and in its bushy and wooded surroundings. Soil profiles were cut and samples were collected in the bottom of the doline, in the E-W doline-section and on the N and S slopes. Vegetation survey was carried out at the same sites in units of 2x2 m. Species composition and coverage % were detected /Table 1/.

Soil samples were analyzed in laboratory for chemical reaction, mechanical composition and dimension of soil-life /number of bacteria/. Plant associations were surveyed with their soils.

Description

In the bottom of the doline there is a deep soil profile formed of 3 horizons and a thin humus cover. Underneath there is a dark brown layer rich in iron, transiting into a clayey middle, then into a red lower layer. The sediments with some red clay layers are several metres thick here, due to lateral soil run off. The mesophyllic soil here is rich in nutrients and provides

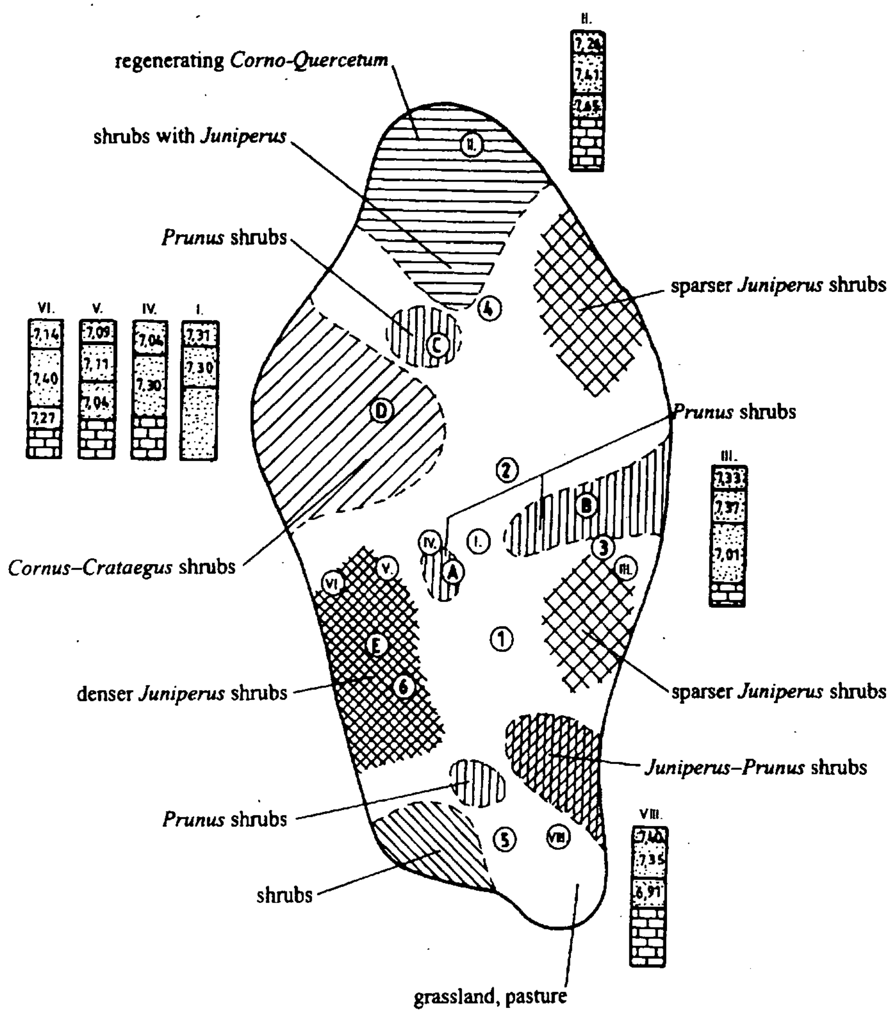

Figure 1 *Plantecological wits in the Great Doline of Aggtelek*

	1	2	3	4	5	6	7	8
Festucetalia valesiaceae								
Agropyron intermedium					25			
Dorycnium herbaceum			8		4	4	+	
Festuca rupicola	6	6	6	3	6	35	6	5
Fragaria viridis	1.5	1.5	+		2.5	+	1.5	6
Seseli varium							1	+
Festuco-Brometea								
Agrimonia eupatoria	15	17	1.5	3	15	1	4	12
Agropyron repens	2	2						
Asperula cynanchica		+		+				
Aster linosyris	+							
Carlina vulgaris						+		
Eryngium campestre			1			5		
Filipendula vulgaris	+			+			2.5	1
Galium verum	2	12	1		3		0.5	
Hieracium pilosella				2		1.5	2	2
Hypericum perforatum					+			
Koeleria cristata			+	1.5				
Poa angustifolia								+
Potentilla arenaria					1.5			0.5
Potentilla argentea					+			
Scabiosa ochroleuca			2.5	+	+	0.5	0.5	+
Sedum sexangulare				2	0.5			
Teucrium chamaedrys			+	7	9			2
Veronica spicata		+		1	4	1.5	+	
Nardetalia & Nardo-Callunetea								
Alchemilla sp.		+						
Agrostis tenuis	1	+		1		4	1	5
Juniperus communis					0.5			
Viola canina	+			+		2	0.5	
egyéb fajok								
Bromus sp.	+							
Cuscuta sp.		1						
Inula britannica			1	+		4		
Ranunculus sp.						+	+	+
Thymus sp.	1	2	1	15	2	2.5	4	4
Trifolium arvense			+		+			
Trifolium sp.						1	+	1.5
Veronica sp.	+		+					

Table 1A. *Phytocoenological types in the Great Doline.*

	1	2	3	4	5	6	7	8
Arrhenatheretalia & Arrhenatheretea & Molinietalia & Molinio-Juncetea								
Achillea millefolium	3	3	5	5	1	7	2.5	1.5
Anthoxanthum odoratum								+
Arrhenatherum elatius	15	1		4		1	15	1
Briza media				1		+	+	+
Centaure pannonica		1	+				1	
Coronilla varia		3		1.5		3		+
Daucus carota	+	1	+			+		+
Euphrasia stricta						+		
Genista tinctoria			2		+			
Leontodon autumnalis	0.5	3	+		+	5	7	4
Lotus corniculatus	1	1.5	+				0.5	
Pimpinella saxifraga	1	1	0.5	+	+	+	0.5	1.5
Plantago lanceolata		1	1		1.5	+	+	1
Plantago media	1	4		8	+	6	7	1
Potentilla reptans	7	1.5		8		1.5	1.5	+
Prunella vulgaris			1	2		1.5	0.5	1.5
Trifolium repens						+	+	+
Chenopodietea & Secalietea & Plantaginetea								
Cirsium arvense	1	3						
Cirsium vulgare				+	+			
Convolvulus arvensis		1.5	+	+		0.5		
Dipsacus laciniatus		0.5						
Euphorbia cyparissias							+	
Prunetalia								
Crataegus monogyna						+		
Prunus spinosa	+					1	1.5	
Querco-Fagetea & Quercetea pubescenti-petraeae								
Astragalus glycyphyllus	3							
Brachypodium pinnatum				25				
Clinopodium vulgare					+	0.5		
Galium mollugo		+				+		
Glechoma hederacea		+						
Ligustrum vulgare					1			
Quercus cerris								+
Quercus petraea						+		
Viola hirta		+	1	1.5	1	3	+	2

Table 1B. *Phytocoenological types in the Great Doline* an excellent living site. Its vegetation is a moderately degraded lawn association, though when compared to the whole of the doline's vegetation it is relatively the most degraded due to nitrophyllic weeds striving on the nutrients accumulated in the bottom. The stand is composed of Festuca rupicola, Agrostis tenuis and Arrhenetherum elatius. There are thorny and pricky species here like Dipsacus laciniatus, Cirsium arvense, C. vulgare, Eryngium campestre.

On the E slope /exposed to W/ there is a limestone outcrop with rootkarrens on its surface. Its dark upper layer contains some humus, its light brown middle layer is clayey, while its lower layer is quartz-bearing red clay. Its dominating species like Sedum sexangulare, S. acre and Potentilla arenaria.

On the S slope /exposed to N/ there is less milieu due to self-shadows. The soil is composed of 3 levels: the upper one is brown, there is a clayey one with iron, then red clay at the bottom. The dominating vegetation is composed of Festuca, Agrostis and Arrhenetherum. The grass association is less degraded and more open than the one in the doline's bottom.

On the W slope /exposed to E/ there is light rocky soil layer underlying the dark brown upper level with humus. Its lowest level is red clay with much outcrop. The soil is redeposited here as evidenced by the charcoal remains between the upper, middle and lower levels. Festuca, Agrostis and Arrhenetherum make up the dominant grassy association in the clearings of the juniper. Juniper is characteristic in this part of the doline.

On the N slope /exposed to S/ the soil has a dark brown upper, a brown clayey middle and a red lower layer. Parent rock is situated at a depth of 50 cm. There is some karst-alien, volcanic sediment in the soil here. Vegetation is patched and dominated by Brachypodium pinnatum finding a forest-steppe like environment here.

Besides the Great Doline there was a control vegetation survey in a neighbouring doline. The findings can be summed up below.

Most of the dolines are covered by grass associations dominated by much the same species. Long lasting animal grazing has brought about a patching in the vegetation cover, however. It does not hide the natural and original heteromorphic composition of vegetation within the dolines, e.g. there is a xerophilous and thermophilous vegetation on the steep, rocky E slopes.

Nature conservation value of the dolines' grass associations /Figure 2/ shows that disturbance-resistant weeds make up almost half of the species, while there was only one single protected weed found in the examined area, the lady's mantle /Alchemilla vulgaris/.

Association survey of the lawn types showed that some 30 % of the species belong to the xerophilous and petricolous groups. It is in accordance with the bad water management capacity of the soils on limestone. Fresh and wet meadows were also found in similar dimension. They occur where, like in the bottom of the Great Doline, clay has been accumulated to such an extent that soil has become impermeable, creating a lateral seepage of water.

Lawns exposed to N /4/, and in the bottom of the dolines /1/ are very different as far as their water budget /W/ soil reaction /R/ and nitrogen demand /N/ is concerned /Figure 3./

On the S slope /exposed to N/ dominated by strong self-shadow effect, the grass association is composed of sort of hydrophillic, medium nitrogen demanding species finding habitation on acid soils as well. In the bottom of the doline, however, where water is concentrated due to run off, soil is wetter, wash out is stronger /soil reaction has got a lower value/. Nitrogen demand is higher here at the same time, allowing the conclusion that degradation has caused the species of high nitrogen demand to spread. Ecological conditions are very similar here to that of the slopes of N exposure. The other extremity occurs on the W facing slopes, where species require very little humidity, low nitrogen demand and a relatively high soil reaction value /lime demand/.

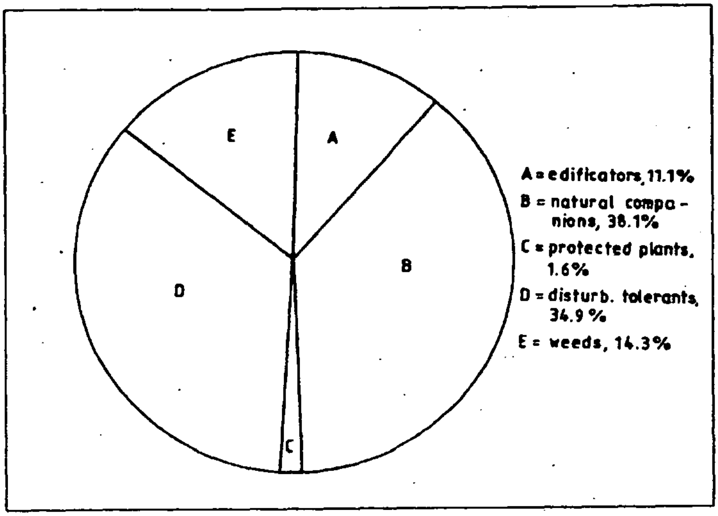

Figure 2 *Nature conservation value of the dolines grass association*

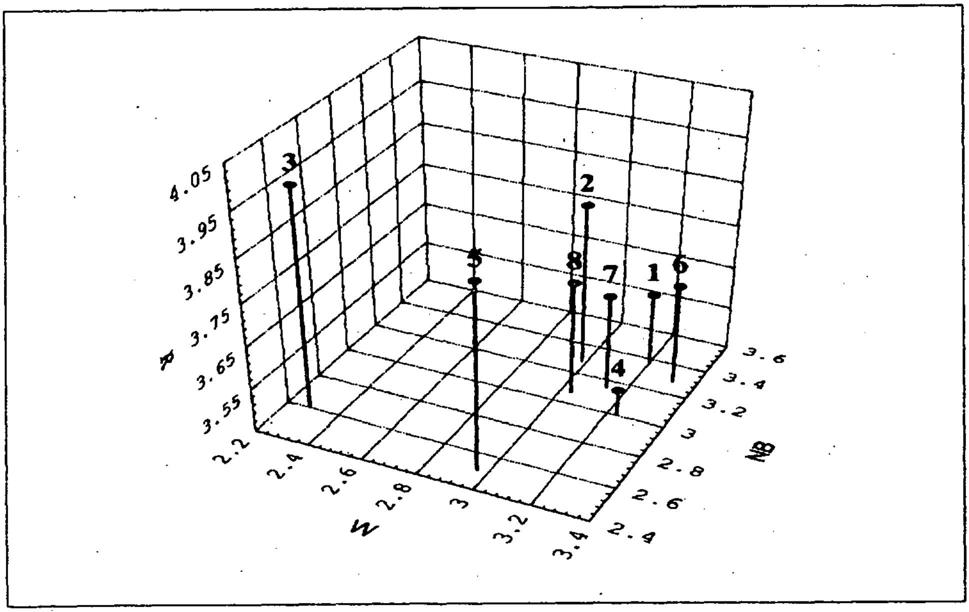

Figure 3 *Value of ecological indicators /W-water budget, R-soil reaction, N-nitrogen demand/ in the doline.*

Results

There are two important development trends in the grassy associations of dolines. Rock grass is formed where soils get dry owing to the microclimate. Where there is less sunshine and wetter soil, shrubby vegetation begins to spread.

Degraded grass-plots can be found where animal grazing used to be intensive: stamping and natural dunging led to a uniform grass association. Pasturing and animal grazing had been preceded by deforestation in the Aggtelek Karst, having led to the formation of secondary grass associations which were then degraded by animal grazing actually.

Figure 4 shows the place and the possible development of the grass associations of dolines within the natural succession. The territory declared as part of the World Heritage has got slowly improving karstecological conditions as compared to its previous state, though further surveys are needed to evaluate the temporal changes. Proposals of practical worth have to be worked out in order to maintain a sustainable landscape development serving both nature conservation policy and land use.

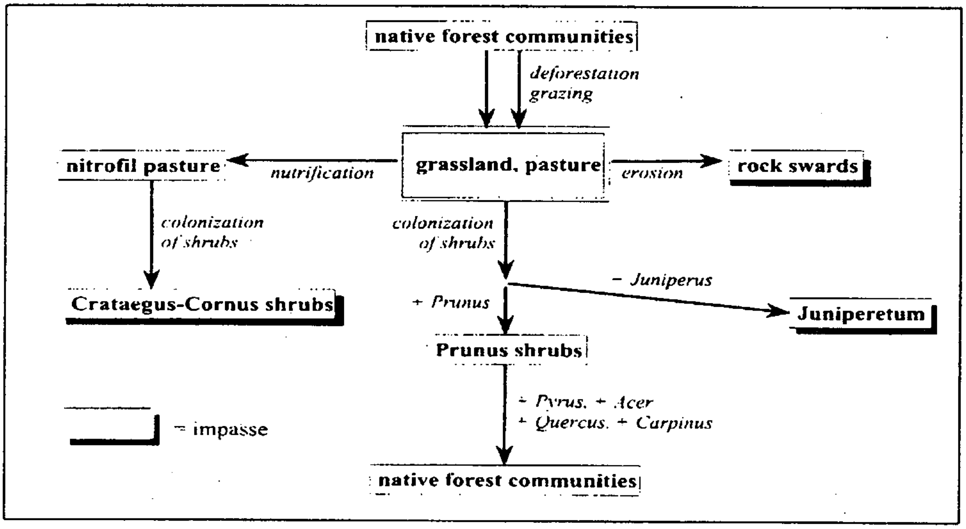

Figure 4 *Possible development of the grass associations of dolines.*

Literature

Pfeffer, K.H. /1990/: Wissenschafliche Informationen zu Karstökosystemen - einewichtige Aufgabe und Planungen. Tübinger Geographiche Studien. Heft. 105. pp. 1-34.

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ECOLOGICAL CONDITION OF HUNGARIAN KARSTS

Ilona Bárány-Kevei

Introduction

The investigation of the karst has been focusing on environmental issues, rather than on the classical karst genetic and karstmorphological ones during the past decades. The environmental impacts of the karst regions have to be analysed, since these processes are very rapid. The non-karstic materials can integrate quickly into the karstwater system, modifying or damaging the natural forms that have been developing for millions of years. Karsts are therefore especially sensitive geoecological systems and their research from this aspect has been encouraged since the 80s (Jakucs, L. 1980, Kevei-Bárány, I. 1982, Pfeffer, K.H. 1990).

Karst areas of Hungary occupy 1.5% of the country's surfaces. Larger part of Hungarian karst lies in the Hungarian Mountain Range.

Hungarian karst systems have been used for a long time. The karst regions of Transdanubia are strongly affected by settlements and industry. Bauxite mining resulted in a considerable decrease of karstwater table (Rétvári, L. - Tózsa, I. 1996). Similarly, most of the Mecsek and the Villányi karst areas have changed due to human activity. The karst region of the Bükk Mts has preserved most of its original character, owing to the protective impact of the Bükk National Park, becoming a conservation area much sooner than the other karst regions. The Aggtelek Region has been a National Park for 10 years, thus human impacts are also relatively little, however, due to the grazing agricultural activity and forestry prior to the conservation act of the national park, some traces of human impact still can be perceived.

Now that Baradla Cave with its Domica Branch on the Slovakian side became World Heritage Area (1996), the geoecological investigation of the larst cannot be neglected in landscape protection.

Methods

The research of the karstecological system has methods applicable to all kinds of karst regions. When investigating the factors of the system (soil, microclimate, vegetation and microbial activity) the methods of the scientific fields can be applied respectively. The parametres of the soil samples from the outcrops were analyzed in laboratory: grain composition (aerometrical analysis), carbonate content (Scheibler's calcium-meter), pH value (digital pH meter), hydrolic acidity (titration), heavy metal content (Perkin - Elmer atomic adsorption spectrophotometer). Nutrient analysis and the definition of the water soluble ions were carried out at the MÉM NAK Institute at Hódmezővásárhely according to the Hungarian standards.

During microclimate monitoring, the soil temperature just beneath the surface, the soil temperature, the sunshine hours and the wind velocity were measured by Assmann's psichrometers, electric resistance meters, Campbell - Stocks radiation meters and anemometers respectively.

Vegetation was surveyed on several occasions on the basis of a 1 sq m grid pattern where both the species and the coverage percentage were recorded. Knowing the species, the karst vegetation was evaluated through using the ecological indicators (water budget, heat budget, soil reaction and nitrogene demand) given by Zólyomi, B.

The survey of the microflora (defining the number of aerobic and anaerobic bacteria on Agar nutritive soil) was carried out at the Microbiological department of the József A. University, Szeged.

Discussion

The relationship among soils, microclimate and vegetation was surveyed on Hungarian karst areas, since the above elements of karstecological systems exercise influence on the whole of the karst.

1. ***Karst soils*** between the exosphere and the rock layers, play an important role in the karst processes. On karst surfaces covered with soil, the decomposition of the organic materials of the karst and the root respiration produce a great deal of CO_2 surplus, increasing considerably the corrosion capacity of leaking waters (Jakucs, L. 1971). In this sense, soil can be considered as an indicator sphere of the karst ecosystem.

1. The ***physical and chemical characteristics of karst soils*** are of relevant importance from the viewpoint of the karst ecosystem changeability. Soils can buffer the extreme impacts, though in case of very strong influences they themselves serve as agents in intensifying the impacts, may they be either favourable or disadvantageous. The inner dynamism of the soil is independent (Szabó, M. 1995), since the enzymes getting into the soil stay there for long, influencing soil dynamism. It is expressed first of all in the chemical features of soil and exercise impact on the development of soil aggregates (structural soil elements). The structure and texture of soil define the soil's air, water and heat budgets. As it can be expected from the above, the chemical and physical features change depending on the biological activity.

Karst soils are not well sorted according to their ***physical quality***; they are unconsolidated, immature soils. They are developed mainly on solution residue or on loess, loess-like sediments. Their dominant fraction is slimy loam (50-60 %), while sand fraction is hardly represented in the Bükk dolines. The soils at Aggtelek are poorly sorted, too. Their clay content is 20 %, higher than that of the soils in the Mecsek karst region (Fig.-1.) This considerable clay content is due to the dolines being older at Aggtelek than in the Mecsek Mts. These soils have large water storing capacity. The thick clayey sediments can eventually become impermeable. In the karst depressions this clay sedimentation makes the karst corrosion effects move towards the edges.

The pH, hydrolitic acidity, alkality and the $CaCO_3$ content describe the ***chemical state of soils***. The water soluble anions and cations, being important from karst corrosion aspect, also represent the chemical properties of soils.

Soil reactions are slightly acid or neutral as decided by their pH values. The soils in the Mecsek and Aggtelek Mts are more acidic with 6.0 - 6.5 average pH values. The soils at Aggtelek have 0.3 - 0.4 less pH than those in the Mecsek, as it was found in the measurement records from the 80s and 90s. Of course, among the several hundred data recording sites, there were found values of 5, too, indicating the aridification process (in the summer of 1995 Calluna was found on the karst surface at Aggtelek). At the same time it is known that the chemical reaction of the karst soils formed on the non-acid limestone, is

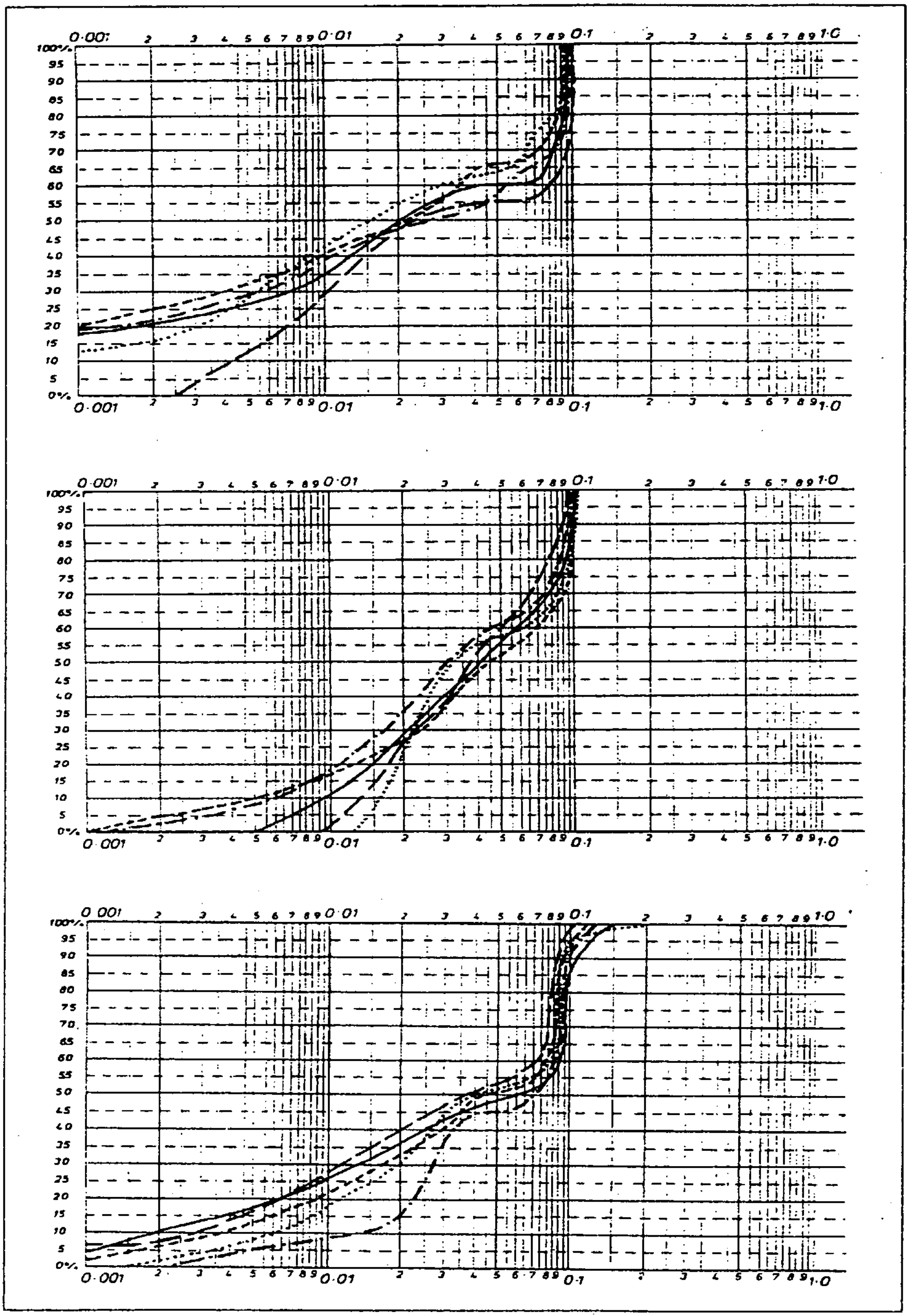

Figure 1 *Fractions of doline soils in Aggtelek-, Mecsek- and BükkMts. (depth 50 cm)*

generally non-acid. The occasionally low pH values encouraged the investigation of the difference between the soil solutions with water and with potassium chloride seperately. The increase of the difference between the two values proves the acidification of the soil (Stefanovics, P. 1981). The difference between the two pH values exceeds the limit indicating aridification in the dolines of the Bükk, Aggtelek and Mecsek Mts alike. The aridification tendency can be found at places where there is little human effect (e.g. in the Bükk National Park). The effect of acid deposition can be anticipated at these sites.

The analysis of ***water soluble cations and anions*** can be applied to describe the chemical state of the soil. Naturally, the Ca^{2+} ion content is high in karst soils, but K^+, Na^+ and Mg^{2+} ions are also abundant. Anions are represented in largest number by SO_4^{2-} but there are many Cl^-, too. There is a general tendency that both cations and anions can be found on the slopes near the edges of the dolines, rather than at their bottoms. The minimum quantity of ions deposited at the bottom indicates the intensive leaching process in this level.

The considerable amount of ***heavy metals*** accumulated in soils can indicate ecological changes. Heavy metal analyses were performed with the soil samples from Aggtelek, Bükk and Mecsek Mts. The average element concentration in limestone:

Zn	Mn	Fe	Co	Ni	Pb	Cu
23	700	15000	2	15	5	4

Heavy metal content at Aggtelek in ppm:

	Al	Zn	Mn	Fe	Co	Ni	Pb	Cu
1	23575.0	148.75	2125.0	27150.0	17.5	37.75	54.75	57.4
2	34055.0	96.25	1225.0	32115.0	24.35	36.45	38.25	18.5
3	29695.0	100.0	1587.5	30828.75	23.4625	33.6125	27.75	18.75
4	35462.5	76.25	1400.0	75873.75	35.0	33.25	162.5	28.25
5	26912.5	126.25	1487.5	29670.0	20.225	32.225	78.75	32.5

1 = N slope, 2 = E slope, 3 = W slope, 4 = depression of Lake Vörös, 5 = SW slope

Heavy metal content in the Bükk Mts in ppm:

	Al	Zn	Mn	Fe	Co	Ni	Pb	Cu
1	30767.5	105.0	1250.0	28882.5	19.4874	31.425	55.5	28.25
2	21115.0	118.75	1450.0	19413.75	12.1125	20.9125	46.25	19.25
3	25572.5	123.75	2000.0	26917.5	23.325	24.275	52.5	22.25
4	23687.5	75.0	837.5	21243.75	21.5625	21.44375	52.875	12.0
5	28082.5	211.25	2087.5	31175.25	16.575	35.325	58.25	50.0

1 = E slope, 2 = bottom of doline 20 cm, 3 = bottom of doline 80 cm, 4 = pinewood, 5 = NE slope

Heavy metal content in the Mecsek Mts in ppm:

	Al	Zn	Mn	Fe	Co	Ni	Pb	Cu
1	18865.0	67.5	737.5	22132.5	15.425	22.725	18.25	14.25
2	18470.0	65.0	787.5	22547.5	15.4	24.425	37.5	15.0
3	24045.0	76.25	400.0	32727.5	14.45	23.2	7.75	10.25
4	18990.0	70.0	662.5	22216.25	15.425	24.3	26.25	11.25

1 = S slope, 2 = N slope, 3 = W slope, 4 = E slope

The above data show that the high heavy metal content of karst soils comes from the rocks only partially. The values are higher in all the three types of karst samples than they should be if originating from rocks alone. The absorption of the heavy metals depend on the clay and organic material content and the chemical reaction of the soils. The higher the clay and organic material content, the more heavy metals are bound on the colloids. Neutral chemical reaction also supports the absorption of heavy metals. In strongly acidic soils most of the metals enter solutions.

The values shown in the tables are the highest ones for each element. Most of them are not well tolerated in the soil. The high metal content in residue terra rossa soils at Aggtelek is natural. Most of the samples come from dolines. No 4 among the Bükk samples is from forest soil on the edge of a doline. Here, with the exeption of Co, all elements have lower values than in the samples from the doline soils. It can be explained with the trees taking up more heavy metals than grass vegetation. Heavy metal content deserves a thorough ecological analysis.

2. The intensity of ***microbial activity*** is affected by the pH and ion content of the soil. There are millions of soil microbes (bacteria, ray fungi and microbial fungi) in 1 g of soil. More than two thirds of the CO_2 emitted in soil come from the decomposition of this organic material population, and only one third comes from root respiration. The most intensive CO_2 production is proven to take place in the upper 20 - 30 cm soil layer, as a result of the aerobic bacteria's activity. Bacterial activity is depending on the temperature and humidity of the soil. If temperature is low (e.g. lower than 20 °C) bacterial activity is slowed down. Low soil humidity (e.g. under 20 - 30 volume %) is also responsible for little microbial activity. The dynamism of the soil is thus manifested in a very complicated system and the least change in any of the factors might result in a very considerable feedback in whole of the karst system.

In surveying the microbial activity of the Bükk and the Aggtelek soil samples, the karst soils were not found advantageous for microbial activity (Kevei-Bárány, I. 1988.). Forest soils have 15-20 million bacteria in 1 g, being much less both in forested and grassy environments. There is a significant relation between the number of bacteria and soil temperature in the near-surface layers of the doline soils. In deeper layers, however, the number of bacteria correlates with humidity rather than temperature. Under Hungarian climate in the karst areas soil humidity under 22.2 - 24.6 °C and 14 - 25 % dryweight represents the optimum range for microbial activity.

The researches performed in the summer 1995 in the Aggtelek Karst (Fig 2.) prove the earlier assumptions regarding higher number of microbes near the surface of the soil than deeper, and the microbial activity being more intensive in forest association than elsewhere. The quantity of CO_2 emitted by microbes is a real ecological entity. The three levels of soil profiles investigated (1/1 = near-surface, 1/2 = middle level of the profile, 1/3 = lower level of the profile) are situatd in the upper 60 - 70 cm of the soil. Microbe number is considerably decreased in the lower level. The significant processes of soil dynamism take place in this profile. The near-surface physical, chemical and biological processes induxe the material and energy flows in the lower depth. Therefore the impacts on the system can cause considerable changes in the upper part of the soil. Biological processes have a feed back on the chemical properties of the soil through the decomposition of the humus materials, so the upkeep of the natural bacterial population and condition is desirable.

3. The dominant factor of karst formation and development is *climate*, but the mechanism of the ecological factors is determined by ***microclimate*** first of all.

Microclimatic systems modifying the radiation impact are formed within the mountainous and valley local climates under specific orographic and morphologic conditions in the Hungarian karsts. The independent microclimatic areas of the karst dolines are the most characteristic where the microclimate modifying effect of the exposure prevails side by side with the effect coming from the enclosure of the depression (Kevei-Bárány, I. 1985). The differentiated warming up of the different slopes results in important differences in the energy input and temperature of the soil. Differences in temperature affect both the microbial activity and the composition of the macroflora. Temperature conditions of the W and NW slopes are found to meet the demands of bacterial activity the best. The drying soils prevent the bacterial population from booming, due to the high humidity and low temperature of the S slope and the strong radiation input of the N slope. If the whole ecological system is considered, this results in a slower decomposition and transport of organic materials on the S slope than on the other ones. The slope-depending differences in daytime radiation input are not compensated for by the night-time heat emission, since the flow of the cold air causes cold-air ponds formed in the dolines. Thermal inversion is occurring. This microclimatic feature results in the specific inverse distribution of vegetation, too. Vegetation is lower in the bottom of the doline than along its edges.

3. ***Vegetation*** cover exercises a strong influence on the processes in the soils of the karst. The karst shrub woods (Orno-Cotinion) are characteristic of the Hungarian karst areas. The mountainous alteration of the Central European beechwood (Fagion medio-europaeum) covers the karst surface above 700 m elevation in the Bükk Mts. Its Central-Range-type streches down into the oak belt. There was a considerable clearing of the forests in the Central-Range in the beginning of the century. The barren lands of the karst surfaces, having appeared after deforestation still can be recognized at spots, but it is not characteristic in Hungary. The only traces of deforestation can be seen in the very slow natural re-forestation of the dolines, or in their still being treeless. In most of the dry valleys juniper occurred following deforestation as a secondary association and it shows the soils being poor in nutrients. The doline vegetation which used to have a rich variety of species is now getting uniformized. Grazing also contributed to the drop in the diversity of species. This, and the extreme temperature values of the microclimate of the dolines explain the associations getting ever poorer in variety of species.

The composition of the vegetation species of the Bükk dolines reflects the cenological features of the karst. The species mapped included those characteristic of the mountainous and submontane beech wood as well as steppe meadow, rocky and pusta grassland slopes, tufted grass and montane hayfields. The average values of the ecological indicators (water and heat budgets, soil reaction and nitrogene demand) were examined and the diagram was drawn (Fig. 3.) on the basis of sampling doline in the Bükk Mts. There is no significant heat budget difference among the vegetation species found in the Bükk dolines, but since this area is a microregion, even the 0.45 difference cannot be neglected. The higher heat budget indicating value recorded on the N slopes proves the aridity of this slope. This feature affects the development of all the other ecological factors.

The effect of the exposure is also characteristic in the analysis of the water budget indicator. Its average value is 6.62 in the N, and 3,2 in the S halves of the dolines, showing the slope-dependent distribution of soil humidity. Like heat and water budgets, the differences in soil reactions are also significant.

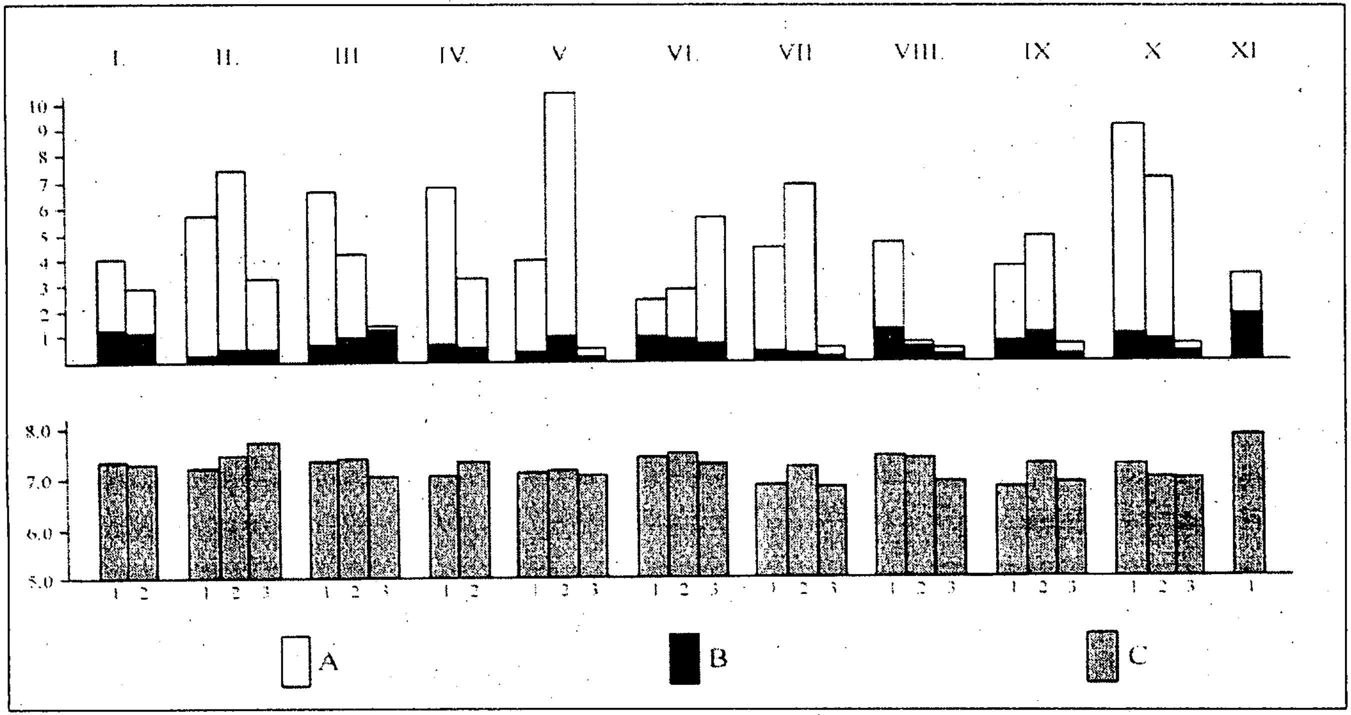

Figure 2. *Number of bacterium and pH values in soils of Aggtelek doline (1995, Hungary)*
I=bottom of doline, II=N-slope, III=E-slope, IV=bottom of W-slope, V=middle of W-slope, VI=top of W-slope, VII=wood on upper part of W-slope, VIII=top of S-slope, IX=W-slope of Szár Mts., X=bottom of E-slope, XI=middle of E-slope, A=number of aerob bacterium (10^6/g), B= number of anaerob bacterium (10^4/g), C=pH value

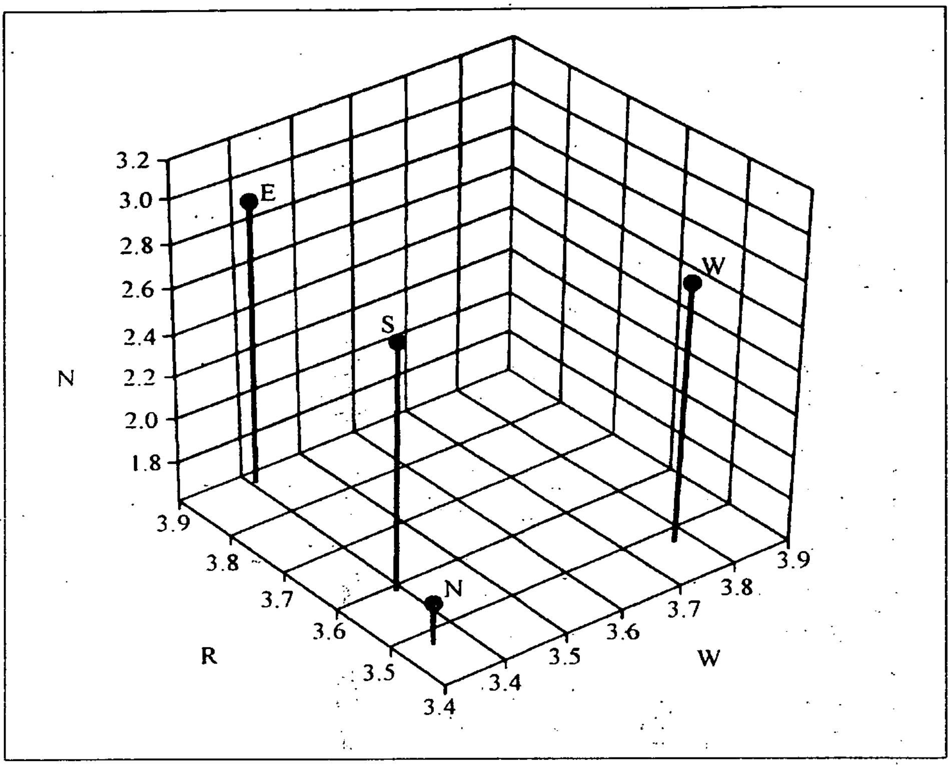

Figure 3. *Ecological indicators of vegetation in Aggtelek doline. W=water budget, R=soil reaction, N=Nitrogen demand. N= Northern slope, E=Eastern slope, S=Southern slope, W= Western slope*

The ecological values measured at Aggtelek (Bárány-Kevei,I.-Horváth,A.,1996) differ from those measured in the Bükk Mts), the species having less nitrogene are more abundant at Aggtelek. It is due to the former intensive grazing, having increased the nitrogene content of the soil. There are many species here, not being members of the original association. Temperature indicators prove the presence of the deciduous and Sub-Mediterranean climates of the temperate zone occurring over the karst vegetation. Average indicators of the water budget show temperate-fres and temperate-dry characters. From this aspect the slopes do not play as important role in making differences as in the Bükk dolines.

The distribution of the species in the doline-grass was examined according to their environmental value. Weeds and disturbance-tolerating species were found to represent 50 % of all the species and it is the sign of disturbed grassland.

After comparing the environmental values of the vegetation associations of the Bükk and the Aggtelek dolines, they were found to be much more degraded at Aggtelek.

Summing it up: the vegetation developed on karstic rocks with rendzina and clayey soils of forest soil dynamics, has very specific components. The species make up associations here that can adopt themselves to the extreme water budget of the soil. If the vegetation changes, like at Aggtelek, both the intensity of karst corrosion and the further functioning of the karst ecosystem are subjects to change. The degradation of vegetation is acting against natural processes as shown in the appearance of a few heather species along the edges of the dolines. Their coverage percent is small, but they are the environmental indicators of the change.

Synthesis

The first sphere of the karstecological system is the air just above the surface (Fig. 4), where there is a karst microclimate formed in accordance with the microclimatic factors. Macroclimate is responsible for the quantity and intensity of precipitation and microclimatic effects modify the quantity of water infiltrating into the rocks. Microclimate affects the development of vegetation , influencing in turn the quantity of CO_2 produced during root respiration. The microclimate of the air just above the surface is responsible for soil temperature and humidity. Millions of microorganisms live in the soil, changing the components of soil-air through the decomposition of organic materials and through their own metabolism. They also influence the physical and chemical soil properties indirectly. The latter result in the change of the quality of seeping water, leading to karstcorrosion processes of different intensities. The inner dynamism of soil can prevent extreme changes occurring in the system (through buffer ability and redox potential), though it cannot compensate for disadvantageous processes of long duration. The inner dynamism of soil can change on the long term, possibly leading to malefunction in the whole system. The changes due to external effects are reversible down to the rock boundary. The materials and the energies conveying them cannot be influenced any longer; when they have entered the rock layer, they become irreversible. Water in the rock layer is the transporting agent of materials and energy. This water reaches the surface again in karst springs and if it is polluted, its value of exploitation is decreased. Another irreversible process, the dripstone degradation can also be due to polluted water entering the caves (Jakucs, L. 1987).

On the basis of the above, the karstecological system is such a structured and dynamic one in which rock, soil, microclimate and macroclimate represent the abiogenic elements, while microflora, macroflora represent the biogenic ones. The interrelationship of the biogenic and abiogenic elements, along with the material and energy flux occurring in this interrelationship keep up the development and movement of the system. Its structure is defined by the vertical and horizontal distributions of its elements. It specific features include its sensitivity, the rapidity of its processes and its three-dimensional surface of effects.

The products of these interrelated processes were studied on the examples of karst dolines. The ecological survey of karst dolines is especially important, since these depressions of the karst are the most endangered points of the system, swallowing more water into the system than any other areas of the karst.

The future exploitation and management of the karst areas has to rely on the knowledge concerning the function of the karstecological system. This knowledge can only be acquired within the frame of the landscape ecological methods.

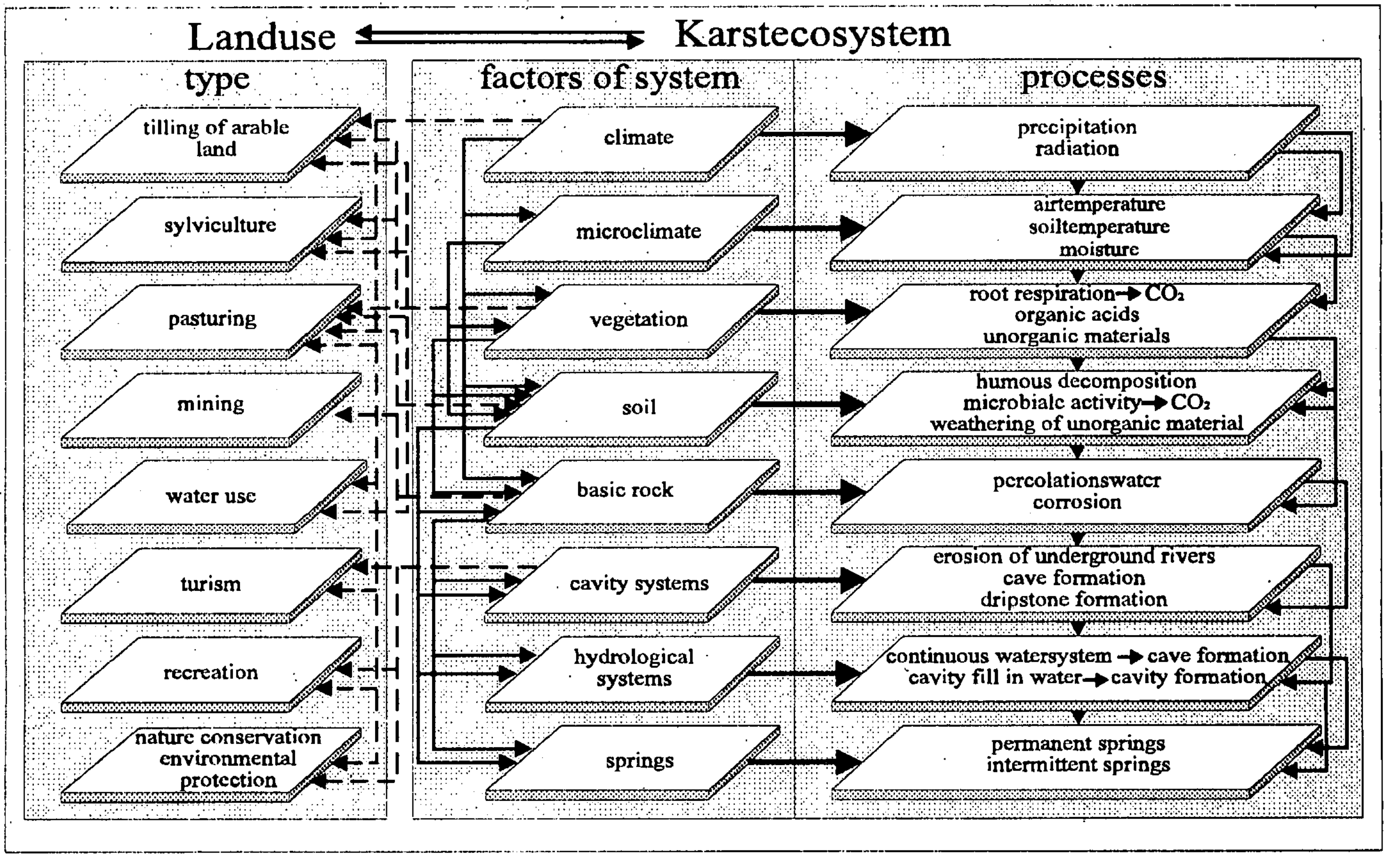

Figure 4. *Structure and processes of karstecosystem*

References

BÁRÁNY - KEVEI,I.1985. Ökologische Untersuchung der Karstdolinen unter besonderer Berücksichtigung des Mikroklimas. Acta Geographica Univ. Syegediensis.Tom.XXV.pp.109-130.

BÁRÁNY - KEVEI,I - Zámbó,L.1988. Study of the relationship between bacteria activity in karstic soils and corrosion. Ann.Univ.Scient.Budapestiensis de Rolando Eötvös Nominatae.Sectio Geogr.Tom XX-XXI.pp.325-334.

BÁRÁNY - KEVEI,I. 1992. Les facteurs écologiques dans la formation du karst. In.: Karst et Évolutions Climatiques. Hommage a Jean Nicod.Press.Univ.de Bordeaux.pp.53-59.

JAKUCS,L.1980. A karszt biológiai produktum (Karst is biological product).Földrajzi Közlemények 28.4.pp.331-339.

JAKUCS,L. 1987. Traces of effects of acid rain (sedimentation) in the re-dissolution of cave dripstones.Endins,n.°13.Ciutat de Mallorca.pp.49-57.

PFEFFER,K-H. 1990.in.: Fragestellungen. Wissentschaftliche Informationen zu Karst-Ökosystemen-eine wichtige Aufgabe für praxisorientierte Forschungen und Planungen. Süddeutsche Karstökosysteme Beitrage zu Grundlagen und praxisorientierten Tübinger Geographische Studien.pp.1-35.

RÉTVÁRI, L. - TÓZSA, I. 1996. Impact of bauxite mining on environmental management. n: Geomorphology and the changing environment in Europe. Abstracts of papers. Ed. by Lóczy, D. - Bassa, L. Bp. Geogr. Res. Inst. HAS.

ZÓLYOMI, B. 1966. Einreichung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR - Zahlen.Fragmente Botanica Musei Historico-Naturalis Hungarici.Tom.IV.Fasc.1 -4. pp.101-142.

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CHANGING LAND USE AROUND SALGÓTARJÁN

Zoltán Karancsi

The investigated area has been shaped by various geological formations and by similarly various human effects being reflected in the ever changing land use.

Animal breeding nomadic peoples lived in this land as early as in 2500 BC (Badenian Culture). The relics of their Copper Age settlements were found near Baglyaskő and Pécskő (Dornyai, B. 1926). In the last period of the Copper Age an ethnic group belonging to the Vucedolian Culture occupied the fertile valleys, driving the small groups of the Badenian Culture into the forests of the higher surfaces. The dwellers of the settlement excavated adapted themselves to their forested environment and they were plant-gathering, deer-hunting breeders of lesser animals (Belitzky, J. 1972).

The peoples of the Iron Age beginning in about 750 BC, were represented by the Scythians for nearly 300 years in the region. Then Celts came (in 250 BC) who introduced ploughing by draught animals, and the usage of the potter's wheel. They maintained a well-developed trade, forming the path leading north along the valleys of the Zagyva and Tarján Streams towards Fülek. This was the first route following the direction of today's Road 21. After the Sarmatan, Hun and Avar rules, this territory became part of the Bulgarian Empire in 803 AD. The earthwork of Somoskő was built by the Slavs to protect and control the N-S trade path. The Hungarian Conquest took place around 899 in this region. The first settlers came here to protect the border-land. First they adapted their way of living to their geographical surroundings and the vegetation cover in order to draw military and agricultural advantages from them. The local Slavs gradually assimilated into the Hungarians, while the latters became ploughmen giving up animal husbandry as a dominant occupation. They cut the ancient forest to gain ploughland. The region became temporarily uninhabited during and after the Mongol Invasion. The increasing power of the aristocracy was manifested in building castles to withstand another, expected Mongol Invasion. The castles built by the Kacsics family (Baglyaskő, Somoskő, Salgó, Zagyvafő) are mentioned in the 14th century documents first (Makkai, L. 1954).

The 14th - 15th century sources indicate an economic prosperity. Newer and newer areas were cultivated. The uninhabited lands of the 13th century had been populated by the middle of the 14th century, due to the landlords' efforts. meanwhile the settlement pattern also changed. The scattered farm-like settlements of the Árpáds' Age were concentrated gradually, the population lived in villages. The quantity and quality of production rose and improved. Winegrowing began in this area in the beginning of the 14th century[1].

[1] Anjou Age rec. II. pp 65-66, 1323 (In: History of Salgótarján. 1972)

When the Turkish invaders appeared in the region (1552), the old castles of Baglyaskő and Zagyvafő were ruins and never rebuilt. Somoskő and Salgó castles had been renewed and reinforced since the 13th century, but neither of them could withstand a serious siege. The Turkish raids resulted in the population perishing and seeking asylium elsewhere. In 1576 Somoskő fell to the Turkish, too, and so the whole region came under direct Turkish rule for 17 years. The anti-Turkish wars and the Turkish Rule led to the total desolation of several villages (Bárna, Zagyvapálfalva, Andrásfalva, Nemti, Somoskőalja) or to the total and final destruction of some (Nagy- and Kisarany, Zagyva, Szőrös, Salgó, Uzsa, etc.). Despite the ever growing burdens, the local peasants' way of living underwent a great change in the 17th century. Some of the deserted villages were re-populated and land cultivation and production was started again. The number of draught animals is a parametre to measure the economic welfare of the peasantry of the age[2]. At the middle of the century there were 2-3 draught animals in a serf's farm on the average, while in 1662 there were 9 according to the records. Peasants under Turkish Rule usually had more animals than those elsewhere[3]. Considereing the constant uncertainty of existence and the two kinds of taxation in the Turkish Rule, it seems to be a contradiction at first sight. The landlords' farming could hardly develop in the Turkish Rule, so socage did not require so much animal power there than in the region outside Turkish occupation. Also, the lands of the destroyed villages offered abundant grassy meadows for animal husbandry and for additional land cultivation. Meanwhile landlords outside the Turkish Rule kept on occupying more and more croplands, fields, woods from the peasants' farms.

After the fall of Rákóczi's War of Independence, the Habsburgs were free to colonize the country, as the aristocracy could go on exploiting the peasantry at the expense of giving up the idea of the independent state. Most of the arable lands were not cultivated or were forested. Landlords allowed their serfs to cultivate the masterless peasant estates. Cropland area was soon multiplied resulting from deforestation and newly cultivated waste fields. Half of the croplands of the Somoskő domain e.g. was a former clearing in 1717[4]. During the Turkish Rule there was a lot of uncultivated land used for extensive animal husbandry by the peasants who drew some profit from this, growing cereals far less than it was possible. As the population went on rising a considerable part of the fields did become croplands again. Animal keeping was no longer preferred to land cultivation thus large scale cattla dealing was replaced by corn trade of similar size. Peasants kept horse and cattle to meet their own demands; for sale they bred seep and pigs. A description given by Mátyás Bél (1742) emphasizes the large scale pig breeding in the Nógrád Forest as one of the main sources of the peasantry's income. Viniculture gained great importance in the first half of the 18th century, too. Wine production was mainly confined to serfs' farms at that time, the vineyards of the aristocracy had played no important role. The development of agriculture was not accompanied by that of industry, however. The landlords' seigniorals domestic economy reached the point by the middle of the century, when it could gain new space only forcefully and at the expense of the peasants' farms. Expropriation of the peasants' lands was started. Most of the croplands cultivated by the serfs were attached to the manors and the socage was also intensified.

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[2] Urbaria et Conscriptiones 66/ 33. 1662 Hungarian National Archives, Budapest

[3] Urbaria et Conscriptiones 96/ 20., 90/ 47. 1662 Hungarian National Archives. Bp.

[4] Urbaria et Conscriptiones. 57/ 38. Hungarian National Archives. Bp.

The lack of industrial development, limited by the Habsburg colonalization policy caused the appearing a mass of cotters being unemployed and vegetating as vagabonds. In spite of growing poverty, the burdens of the serfs kept on growing, too. Finally landlords owned the clearings as well as the common grazing lands and forests and most of the serfs' lands[5].

The preconditions of capitalist production were given by the big mass of people excluded from the feudalist production as free labour force, and by the lands being privately owned by few people. In the first third of the 18th century the 'breadless Tarján' was a well-known name coming from the settlement being unable to grow enough cereals for its population or for its domain in the hilly surroundings, bad croplands and meadows of the village (Bél, M. 1742). The expansion of croplands through clearings began at the time of the re-settlement. The clearings had two problems: the bush vegetation and the erosion could very quickly occur on them leading to their abandonment, or the peasants were likely to keep their cultivation a secret to avoid paying tax on them. What happened to the wood coming from deforestation? It was used for heating, building material and was also sold. Animal stock, extra clearings both contributed to the restructuring of peasantry, some of it getting poorer, some of it richer. Masting was important in the large oakwoods[6]. According to a record from 1726 the croplands of medium quality were cultivated in 3 rotations and they yielded grain four times more than the seed sown. Meadows were of medium quality, too. Cropkands were enalrged by clearings. Forests gave firwood and building material. Logged lands were mown. The domain did not have a vineyard in Tarján, but two fish ponds (Vendégi and Kucordi). To develop the domain Ferenc Szluha wanted to establish a stud and a large scale bee-keeping of 25 hives in Salgótarján in 1726[7]. In 1729 Szluha initiated the consolidation of the domain lands and the prevention of the erosion danger, too. He ordered the lands situated among the seigniorial medows and fields, but belonging to the serfs, to be attached to the domain. And the serfs were given lands elsewhere. In order to stop the washing away of fertile soil, he ordered his farm-bailiffs to have deep furrows ploughed in the upper and lowermost sections of the croplands to avoid the erosional damages caused by sudden rainfalls. He cared about animal keeping as well. He ordered the fish ponds to be cleared and the dams renovated. However, he forbade free masting and tree felling in his forest causing a drop in pig breeding[8]. At the same time he let hunting in autumn and winter for bear and fox hides. In the 1730s sheep breeding spread instead of pig breeding. The deforested areas around the settlements can well be seen in the maps of the Military Survey I (1782), in Fig.1.

The coal reserves of the area were not recognized at first and the self-conbustion and warming up and the smelling of coal gas in the near surface layers were recorded only as natural phenomena. Ferenc Radványi wrote about Vecseklő in 1727: 'A pit is said to be found in our territory which keeps on burning and smoking by itself and it cannot be put out with water.' The 31st Ocober 1767 issue of the Pressburger Zeitung says 'last summer the earth started to burn itself in the Salgó Hill and kept on glowing for two months. Farmers used occasional flames to cook their meals. The earth that burnt became coal.'

[5] Urbaria et Conscriptiones, 86/ 15. Hungarian National Archives, Bp.

[6] Urbaria et Conscriptiones, 57/ 17. Hungarian National Archives, Bp.

[7] Salgó 79 Hungarian National Archives, Bp.

[8] Salgó 97 Hungarian National Archives, Bp.

Figure 1 *First military surveying map (1782)*

The expropriation of the peasants' land went on in the first half of the 19th century. Production of the reduced serfs' lands could not meet the basic demands of the peasants to prevent them from starving. Famines were frequent in the first half of the 19th century (Pulszky, P. 1850). The lands of the aristocracy yielded extra corn to be exported to the Uplands (Losonc), Moravia, Austria. After a drop in the demand for corn, the aristocracy was getting involved in animal husbandry. Wool producing was especially profitable, not only abroad, but in Hungary, too. As the rough fleece of the Hungarian bred sheep was not suitable for industry, the Merino kind was bred (Mocsári, A. 1826). cattle keeping also thrived. Corn was getting difficult to sell, so it was used for large scale distillation and oxen for sale were fed with the by-product. The livestock in the manor needed ever larger pieces of land, so the land owners took land away from the serfs, leaving no space for them to keep their own animals. Feudalism faced a crisis by that time, the contradiction between the peasants and the land owners rose high and movements of the peasantry began to spread. The meadows belonging to Salgó Tarján village were situated north and south of the village in the 200 - 300 m wide valley of the small river. Followung the unconsiderable deforestation the snow melting and the storms caused floods, intensive erosin in the barren hill sides and slime deposition in the valleys. Contemporary descriptions inform us about limetrees and willows almost quite covered with slime in teh Tarján Valley. Slimy sediments were deposited in the meadows, their quality got worse, contributing to the decrease of livestock. Croplands were situated in the low hills around the villages and in the transverse valleys (Ponyi, Diós, baglyasalja Valleys) adjoining the meadows. In the higher surfaces there were barren grazing fields. This land use was very disadvantageous, since erosion was thus let free[9]. The quality of croplands was hardly second class. The serfs' lands being very dissected made cropland cultivation difficult. The pieces of cropland belonging to a serf having quarter ground, were usually situated in at least twelve pieces. Most of these pieces of land were small (400 - 500 sq fathoms), lying far apart from one another and from the village as well. This did no good to their cultivation. All the graze lands and forests of the village were owned by Antal Jankovich. The serfs were permitted to use the fields for grazing and to collect wood in the forest[10]. The most outstanding feature of the Salgótarján landscape used to be the barren and high hills edging the valley up to the middle of the 19th century. The barren grazing fields of very bad quality were dissected with huge and active ravines. The century long deforestation of the ancient Turkey-oak, beech and oakwoods left the landscape barren, or scarcely wooded. The decay of the forest was caused by not the need of new croplands, but the wood supply of glass works, an iron furnace, a cloth factory, the buildings, broom and basket making spread among the local population as a source of income. Forest decay was completed by the introduction of the sheep in the Jankovich domain. The large number of sheep resulted in the unconsiderate deforestation and sheep grazing prevented reforestation.

Deforestation resulted in serious consequences for livestock and crop cultivation alike. Most of the grazing fields were situated on the top of the hills so they were suitable for grazing seasonally. By the middle of the last century, the forest virtually disappeared from the vicinity of Salgótarján. Its remnants were of bad quality. Only barren hills surrounded the settlements. Today's forest covering them was grown later (Kaulfusz, J. 1854).

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[9] Land Registry of Salgótarján: records of the National Inst. for Geodesy and Mapping: and that of the Nógrád County Authority 728/ 1852. (In History of Salgótarján 1972)

[10] Land Registry of Salgótarján, 1852 Archives of Nógrád County. Balassagyarmat (In History of Salgótarján 1972)

It was coal, making Salgótarján an industrial centre and its name well-known. The coal layers in and around Salgótarján were known in the 18th century, though their exploitation began only in the second half of the 19th century with the first Hungarian industrial boom. The first mines of this coal basin were opened at the Zagyva and Inászó estates. The Salgótarján mines were rather coal pits at first. Mines were deepened down to 80 - 100 m only later, following the material in the outcrops. Cribbing and tubbing were not performed regularly, as miners had to supply wood. Transportation was troublesome as well. The nearest coal consumers were located at Eger (mills), and Vác (Danubian steam boats). Also, there were only two coal outcrops at Salgótarján, they were situated in the middle of the coal basin and there were important roads linking them to the country's road network.

Mining changed landscape and induced the infrastructural development. Ramps and tramroads were built on the barren hills. Railway traffic was started between Salgótarján and Pest in 1867. New settlements were built due to coal mining (Salgóbánya, Rónabánya). The forest of the Medves region yielded wood for mining (rail sleepers, mine timbers, firewood, Gajzágó, A. There was a change underground, too. Today there are abandoned and exploited mines situated everywhere beneath Salgótarján. After the coal reserves of the outcrops had been excavated, drift mining was replaced by deep mining requiring more technical knowledge and facilities (Andreics, J. 1894).

Another important mineral resource was the basalt of Medves. Its mining was started in 1878 in the Bagókő-quarry. At first its owners did not plan its exploitation, they were not interested in the mining conditions, but profit only. The deadrock thus e.g. was placed at a site causing problems for later mining.

The local and developing industry increased the food market too, therefore land owners (both peasant farmers and aristocrats) tried to expand their areas of crop cultivation. During 1859-95 forests turned into croplands occupied 600 acres, while newly ploughed meadows mounted to 400 acres. This 1100 acre territory was not all added to cropland, as pieces of the farmers' former lands were built up. The proportion of meadows went on decreasing. The little remaining meadows were owned by the aristocracy. It had a catastrophic effect on farmers' households. The growing demand for transportation facilities and for dairy products and meat made the farmers keep more and more draught and farm animals. They had no access, however, to the meadows needed for livestock keeping, so they had to grow fodder on their croplands or buy fodder. Both draught and farm animal stocks kept on increasing. The development of animal keeping resulted in the peasantry taking part in the traffic created by the increasing industry and commerce, with their draught animals. At the same time their agricultural activity got confined to growing fodder to feed their livestock. Fruit growing was also attempted in the region as an intensive economic branch. The number of fruit trees grew in the 19th century. In 1895 there were 1535 apple trees, 1697 pear trees registered in the settlement. Orchards producing marketable fruits did not appear, however. The land owning peasants tried to make use of industrialization and the growing population: they gradually sold their pieces of land situated in the inner part of the settlement and they built their new houses closer to their newly occupied lands during the process of consolidation. By the turn of the century, the former Jankovich manor was divided into six large estates. One of them was the Salgótarján Coal Mine Holding with 2383 acres in five villages, and another was the Rimamurány - Salgótarján Iron Works with 1339 acres in two villages. These lands were not cultivated at all, they served the horse keeping function and the wood supply of the mines[11]. These large scale industrial firms purchased the farmers' lands surrounding their mines as it was the only of their spatial development. Peasants were inclined to sell land to the mines as they received a relatively good price for them. By the time of World War I the village with its original population disappeared. The lands were owned by the industry, croplands were replaced by mines and industrial estates. Peasants without their lands became either hauliers or factory workers, craftsmen.

The Salgótarján landscape was described by barren hills, exposed gulleys, waste-tips smoking and burning on the hills and thick smoky dust covering the valley (Szabó, B. 1972). Salgótarján has always belonged to the towns with the least agricultural land per a resident (20 acres). The population employed in agriculture was only 4 % of the total. According to the statistic data, the total agricultural land of the towns was 4783 cadastral acres. Almost half of it (2057 cadastral acres) represented forest, 669 c.acres meadows and only 1594 c.acres were cropland. The out-of-date agriculture can be described by the following data: in 1935 20 % of the total cropland area (1594 c. acres) was manured, out of which there were only 20 c. acres receiving fertilizers. That is only 1.5 % out of the cropland area as opposite to the national average being 7.2 % (Gunst, P. 1970). The structure of agricultural production had barely been modified since the middle of the 1920s. Croplands had low yield and the farmers could not reach a suitable farming level with their simple and traditional tools and with the lack of enough draught animals. Underdeveloped agriculture can be described by the rotation system and the lay-land farming being important even in the 1920s. Beside the extensive fallow, the barren surfaces stricken with erosion grew, due to the unconsiderable deforestation. Also, natural disasters struck large cropland areas year by year[12]. The economic importance of the forest began to grow after World War I, due to the areal changes of the country. The Medves Region had more forest than the national average. However, there was no forestry planned in the 1920s. The owners of the forests did not even plant the free seedlings provided by the state. Among the valuable species beech, oak and some pine couls be found in the forest. The ruthless exploitation of land went on following the harmful practice having appeared in the 19th and in the beginning of the 20th centuries. Land owners continued deforestation resulting in barren fields and hillsides exposed to erosion[13]. The yield of the bad croplands could not be increased during World War II, either. What is more, the production of the small holders was decreasing, as they could not perform thorough soil cultivation or use fertilizers. Also, most of the horses were taken to war and it became troublesome to cultivate the rough surface. Cattle were used as draught animals therefore, which caused a drop in milk production. Animal husbandry remained extensive during the war[14]. Livestock was the largest in 1941. Then it rapidly decreased, as great volumes were taken to Germany and to the army year by year. Except for a little allowence per head, all the corn was taken away from the peasants as delivery. Coal was also used up by the factories serving the army. The remaining coal was not enough to cover the population's need, thus wood-felling had spread as long as it was slowed down again by the lack of labour due to recruitings.

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[11] Cadastral maps ÁFTH; Agricultural Statistics 1895: national list of farmers of the Hungarian Crown. Archives of Nógrád County, Bgy. (In History of Salgótarján 1972)

[12] Goverment reports; statistical year books: 1923-1925 and 1927-1928; total data of crop yields by municipalities (In History of Nógrád County III. 1970)

[13] Statistical year books: 1923-25. 73 p.1927-28. pp.91-97. (In History of Nógrád Country III. 1970)

[14] Statistical Year Book on the government in 1940, 56 p.(In History of Nógrád County III. 1970)

After the war, the agrarian reform made the large estate system come to an end, and the number of farmers grew considerably. The average cropland is Nógrád yielded the least profit in the country: it was 5.91 gold crown per cadastral acre, while the national average was 9.38 in 1951[15]. The rough hilly surface needed special soil cultivation in the croplands. The modem agricultural technology following the rapid change of the ownership and the better crop yields were doubtful to occur due to the lack of up-to-date agrarian technology, fertilizers, etc. From 1948 on, the formation of the farmers' cooperatives and the agricultural cooperatives was launched to strengthen agriculture. After the revolution of 1956 most of the numerous cooperatives of inadequate functioning split up, however, the strong ones did survive (at Cered e.g.), where armed peasants defended the cooperative against forceful closing down[16]. The cooperatives kept on trying to grow corn (maize, potato) even at the end of the 1960s. The establishment of nature conservation areas meant stricker conditions for agriculture. Therefore and because of the unfavourable soil conditions (shallow, clayey brown forest soil) the cooperatives began to grow more and more fodder for their livestock.

In the 1960s coal mines closed down due to their exhausted reserves (Gajzágó, A. 1962).

There was a rising demand for basalt and new quarries were opened (at Salgó and Vecseklő). The basalt was transported by road and rail to road and railway building and to dam construction works (e.g. at River Tisza). Even these basalt quarries were closed down when the demand of the market grew less and when environmental protection began to increase by the beginning of the 1970s. No recultivation plans were made for these spots, so most of the quarries have been untouched since their use was stopped. Some of them became illegal deposits of waste.

The recultivation of the open mines and their surroundings is an important task in landscape reconstruction.

Tourism may considerably contribute to the economic development of Salgótarján, the centre of the region, having excellent natural setting. The basic condition of receiving visitors is accomodation of acceptable quality and quantity (like Karancs, Salgó and Medves Hotels). Its landscape of great variety and acceptable quality is an adequate touristic attraction, too.

[15] Collection of agricultural statistics 1870-1970; Land Register II. County data KSH Bp. 40 and 438 p. Land Register I. National data KSH Bp. 55 p.
[16] In Nógrád Népújság 8th Dec. 1956: In Defending the Cooperatives (In History of Nógrád County IV. 1974)

References

ANDREICS J. 1894: A Salgótarjáni Kőszénbánya Rt. története. (History of the Salgótarján Coal Mine) – Bányászati Kohászati Lapok

BELITZKY J. 1972: Salgótarján története (History of Salgótarján). Salgótarján p.18.

BÉL M. 1742: Notitia Hungariae Novae IV. 33.p.

DORNYAY B. 1926: Adatok Salgótarján és vidéke őskorához. (Data Regarding the Ancient Histrory of Salgótarján) – Salgótarján, 8.p.

GAJZÁGÓ A. 1962: A salgótarjáni Iparvidék. (Industry around Salgótarján) – Salgótarján

GUNST P. 1970: A mezg.-i termelés története Magyarországon. (Histrory of Agricultural Production in Hungary)– Akadémiai kiadó, Bp. p. 414.

KAULFUSZ J. 1854: Nógrádi erdők (Forests in Nógrád) – Gazdasági Lapok

MAKKAI L. 1954: Nógrád megye története 1848-ig (History of Nógrád County till 1848). – In: Genthon I. (szerk.): Nógrád megye műemlékei. pp. 35–83. Bp.

MOCSÁRY A. 1826: Nemes Nógrád vármegyének históriai, geographiai és satisztikai (Historical, Geographical and Statistical Introduction of Nógrád County)esmertetése I-II. Pest

PULSZKY, T. 1850: Az 1846/47-es éhínség leírása (Description of the Famine in 1846/47) – Memoirs of a Hungarian Lady.London 64-68 pp.

SZABÓ B. 1972: Salgótarján a kapitalizmus uralkodóvá válásának időszakában 1848-1918. (Salgótarján at the Time of the Formation of Capitalism: 1848-1918 in History of Salgótarján)– In: Salgótarján története.

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URBAN LAND USE INVESTIGATION WITH GIS AND RS METHODS

László Mucsi

Introduction

Two historical events played a great part in the development of Szeged, the fourth largest town in Hungary. In 1879 about 95% of the buildings were destroyed by catastrophic flooding of the Tisza river. After the flood, and with the help of larger European cities (Brussels, Berlin, Moscow, Paris, etc.), a new structure for the city was planned and built. Avenues and boulevards can now be found in place of ancient streets and buildings.

After the First World War, the area of Hungary was reduced to one third its original size. Before the War, Szeged was relatively central in southern Hungary, approximately 150 km from the southern border. At present, the border lies less than 15 km from the town.

The changing inner and outer conditions were investigated utilizing GIS methods. With the help of the first maps taken after the flood, the changes in the structure of the town were analyzed, and the direction of the expansion in the last 100 years determined. One very interesting task was to compare the development of the town, which was based on natural conditions (geomorphology, river, agricultural lands, etc.) before the flood with the post-war development, which was determined by economic and political decisions (socialist planned economy). The most important factors of the post-flood development were the creation a new road system in a 4-6 m higher position, river regulation (Tisza and Maros rivers), and destroying the main geomorphological forms, etc. These effects changed the hydrogeological conditions of the town and created new engineering-geological conditions. The industrial and economical importance of the town changed in the country, and as a result of inner town development, functionally different districts inside town can be distinguished. The borders of the town have grown with suburban regions being developed and small villages merged with Szeged. The inner city preserved its civil aspects, while "modern" blocks of flats were built in the outer residential area.

Data sources

SPOT P and XS images were also applied together with airphotos and topographic maps (1:10000 and 1:25000 scale, Fig.1-2). Vector and raster based GIS were developed on an Intergraph system at the University of Szeged and the University of Liege, Laboratory SURFACES. The new direction in the development of Szeged was investigated with help of gravitational models.

Different data systems were used during the classification and urban fringe monitoring (Table 1).

type	*date*	*scale*	*projection*
topographic map	1965	1:10000	stereogrpahic
	1988	1:10000	EOTR*
airphoto	1972	1:10000	black&white VIS
	1981	1:10000	black&white VIS
	1982	1:10000	colour infrared
digital image	29.08.1988		SPOT XS 1,2,3 bands
	28.06.1990		SPOT panchromatic

*EOTR = Unified National Mapping System

Table 1 *Characteristics of Data Used*

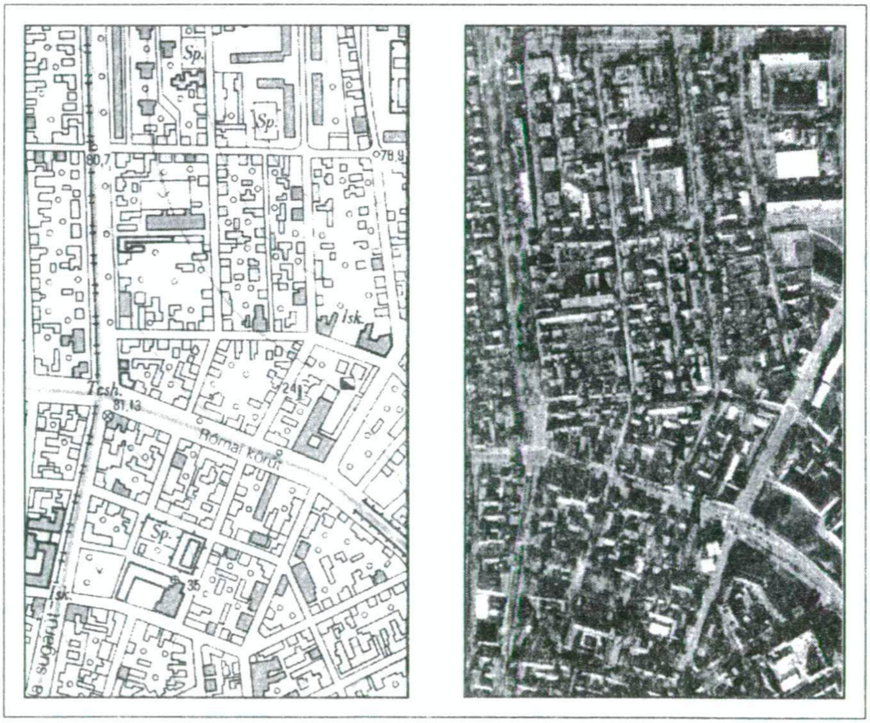


Figure 1 *Topographical map and airphoto as data sources*

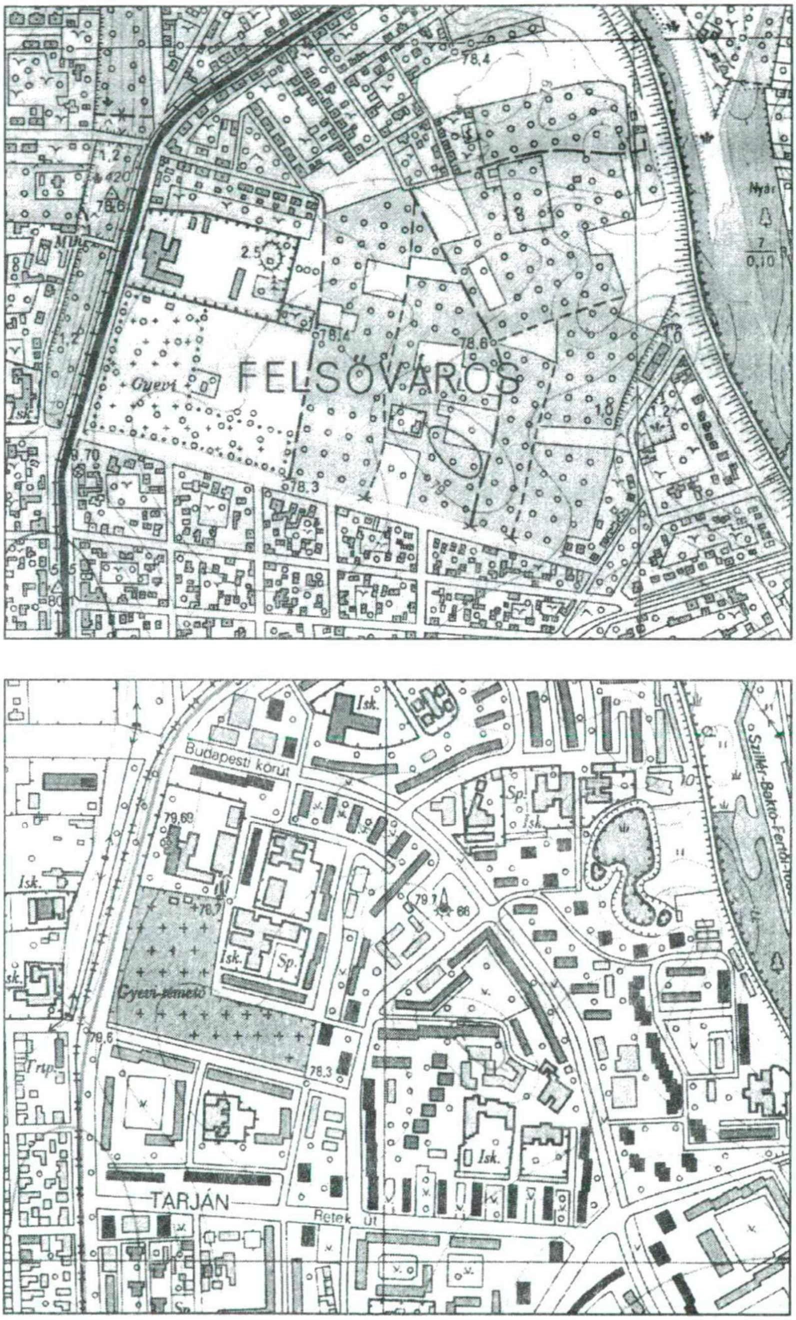


Figure 2 *Topographical maps of one part of Szeged from 1965 and 1988*

Results

The aim of this study was to detect changes in land use from agricultural land to a construction site or housing development.The structure and development of the town of Szeged (South Hungary) have been studied to investigate the possibility of remote sensed data for urban monitoring and change detection. This city and its rural surroundings were chosen because we could investigate areas where urban development has been relatively rapid over the last 20-30 years. Applications forming part of this research include urban fringe monitoring (fringe is an area under constant pressure for change), discrimination of urban classes, prediction of residential housing density, estimation of urban quality measures, socio-economic variables, and population density.

Topographical maps (1965,1988) were digitized and developed on an Intergraph Microstation system at. the University of Szeged and the University of Liege, Laboratory SURFACES. Vector and raster GIS were developed on Intergraph and IDRISI to compare the differences between these systems.

Airphotos were scanned and used as a raster base system. The original photos were magnified to the scale 1:10000 in the photo laboratory of FÖMI (National Remote Sensing Laboratory). The above mentioned topographic maps (image to maps) and SPOT panchromatic image (image to image) were utilized for the geometric correction of airphotos. These photos were acquired on 1972,1981 and 1992.

SPOT XS (1988, 3 bands) and P band (1990) were applied (together with airphotos, and topogrpahic maps, Fig 3.) for supervised and unsupervised classification, and for the investigation of urban change detection. Base problem was that the SPOT images were not acquired at the same time, therefore we were not able to utilize the special XS+P image and different colour composition of XS and P bands (3P1, 32P, etc.). We had to apply XS 321 (RGB) colour composition with 20 resolution and P band independently. Housing density represents a useful input to urban land information systems and inter-census population change studies, but it is not directly observable from spaceborn sensor systems because of their resolution. Even with SPOT's 10 meter resolution P mode data this is still the case because the average low density housing is about the same size as the pixel, and cannot be positively discriminated without an IFOV nearer to 5 meters, Nevertheless, the 10 and 20 meter resolution of SPOT offers the potential of using textural variables for housing density studies (Froster, 1987). The P band image was used for geometric correction of the XS 321 image and for the identification of different buildings and structures.

Our principal task was to detect changes in the structure and development of the town from the latest, most detailed topographic map (published in 1988 but drawn in 1983), and with the help of airphotos and digital images, to complete and refresh the topographic maps on the scale 1:25000. We also tried to classify the urban, rural and agricultural areas. The range of the investigated area was 16*11 km.

Discrimination of highways and estates

Although the inner structure of the town is clearly arranged, especially on the XS3 band (infrared, 0.79-0.89 mm), the difference in the temperatures and infrared reflectance of main streets, buildings, and green surfaces on P band (0.51-0.73 mm), the classification is not so easy. On the 20 resolution XS bands, the greater buildings (Opera, Theatre, Stadium, large workshops, block of flats) can be discriminated, but their form and range cannot. On the P band image we have a better view from these features, but due to the acquisition date difference between the XS and P bands, we had to utilize this P band independently.

Figure 3 *SPOT P image overlaid by topographic map*

On XS 321 (RGB) colour composite, boulevards and avenues are clearly discriminated visually. The classification of the highways is difficult. These road are the most popular region from traffic and geographical potential point of view, therefore housing estates and tall buildings can be found along the wider streets. The SPOT 2 HRV XS and P images were acquired at 09 hour 43 minutes, consequently long shadows of buildings can be detected due to the low angle of incidence of solar radiation. The effect of this phenomenon is extraordinarily strong along streets of N-S direction. According to the colour composite the classification of the Grand and Outer Boulevards, the Kossuth and Kalvaria Avenues is not so difficult because of the 20-30 meter wide asphalt and concrete pavements. Although in this case, the shadow effect of the taller buildings and row houses can disturb the classification, especially along the Outer Boulevard. These new, ten-storied houses were built in the last two decades. Consequently, the main roads can be classified by pixel by pixel method on the XS 321 colour composite, or (2) on the XS 3 black and white image. In the first case more than 20 classes were used with very low standard deviation. Among the older buildings (Tarjan housing estate, Fig 4.airphoto to the rigth) the vegetation has grown stronger, which is favourable for living conditions, but their shadow increases the standard deviation of pixel values of boulevards and avenues. The pixel value of greater green surfaces among the new blocks of flats are very similar to the pixel values of meadows and pastures on the surrounding agricultural regions, therefore a special mask was utilized for delineation of the urban area from the agricultural land. The shadow effect not only disturbs the classification but also gives a good application for the tall building discrimination. Airphotos and SPOT P scene were investigated for the measurement of shadows of different buildings. The simple rule which states that a taller building has a longer shadow than a lower structure (Fig. 4.) can be statistically proved. On raster base GIS this rule can be expressed by the following: there is greater distance between the centre of a pixel meaning a house and pixel meaning the end of the shadow. These measurements were used for the discrimination of the building of a new estate (Fig. 5.), which cannot be found on the newest topographic maps. This method can be applied to the 5- 10 years old settlements, because the gardening is frequently delayed or does not happen after the finishing of construction.

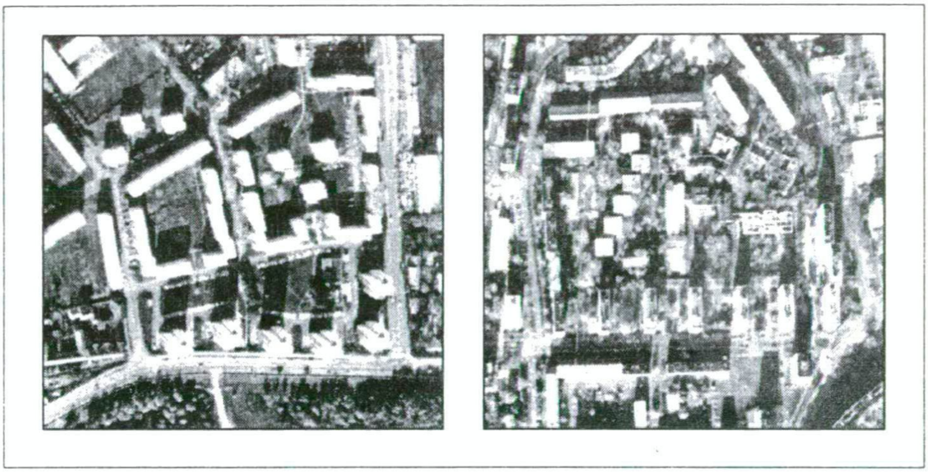


Figure 4. *5 years old (A) and 20 years old house of estates in Szeged*

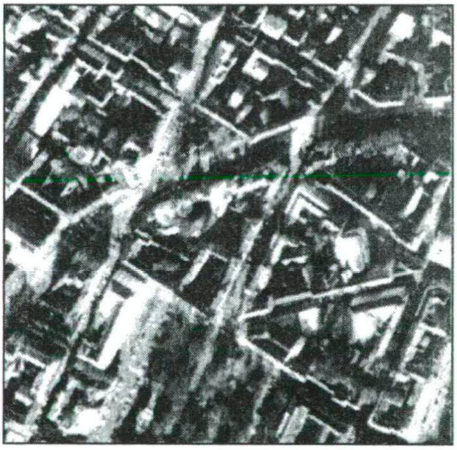
Thus, the following hypothesis (Froster 1987) is not exactly true: "...low density areas would normally have a higher vegetation content than high density areas". It is true only for downtown or CBD's (Central Business District). In the case of Szeged, the central area's delineated by the Grand Boulevard

Monitoring of other urban and rural encroachment

Different types of urban land use can be detected on the investigated area.(1) During the last 25 years, the most important process was the building up of the open space areas in the inner city. Not only the open space areas were used, but also the old, uncomfortable houses were destroyed, especially those on the outer ring between the Grand and Outer Boulevards. On Fig. 2. (upper map) there is an old district near to the Stadium (before 1965). This area is already destroyed (1983, Fig.2. lower map) and a new estate region can be seen on this area on the airphoto (1992, Fig. 4, rigth image).

(2) Aerial and structural changes can be discriminated on those districts which can be characterized as a rural area inside the town. These types of houses are located on the southern part of the town between the Grand and Outer Boulevards (Mora town), The changes can be seen only on the airphotos. On the SPOT P image and airphoto (see image to the ritgh), the aerial development was measured, but the inner structure development cannot be detected due to the 10 m resolution. On this region, the former network of streets did not change, but new blocks of appartements (6-8 families) replaced the old buildings. Similar development occurs outside the circle bank (Petőfi telep, Hattyas, etc.).

(3) On the inner part of the town, the oldest part of the town, insignificant changes can be detected due to the protection of the historic buildings. During the renovation, the material of the roofs changed thus the characteristics of the remote sensed data also changed. On the SPOT P scene greater blocks can be discriminated, but due to the narrow streets between the blocks, the delineation is difficult. The discrimination is possible using airphoto (see image to the ritgh).



Conclusions

With the help of remote sensed data (airphotos and SPOT XS,P images) different urban and rural changes can be investigated. The airphotos were utilized for the detection of structural changes, especially· in rural regions, and XS,P images were used for the aerial measurement and topographical map correction (1:25000 scale, Fig. 5.).

On raster and vector base GIS the urban development can be investigated automatically.

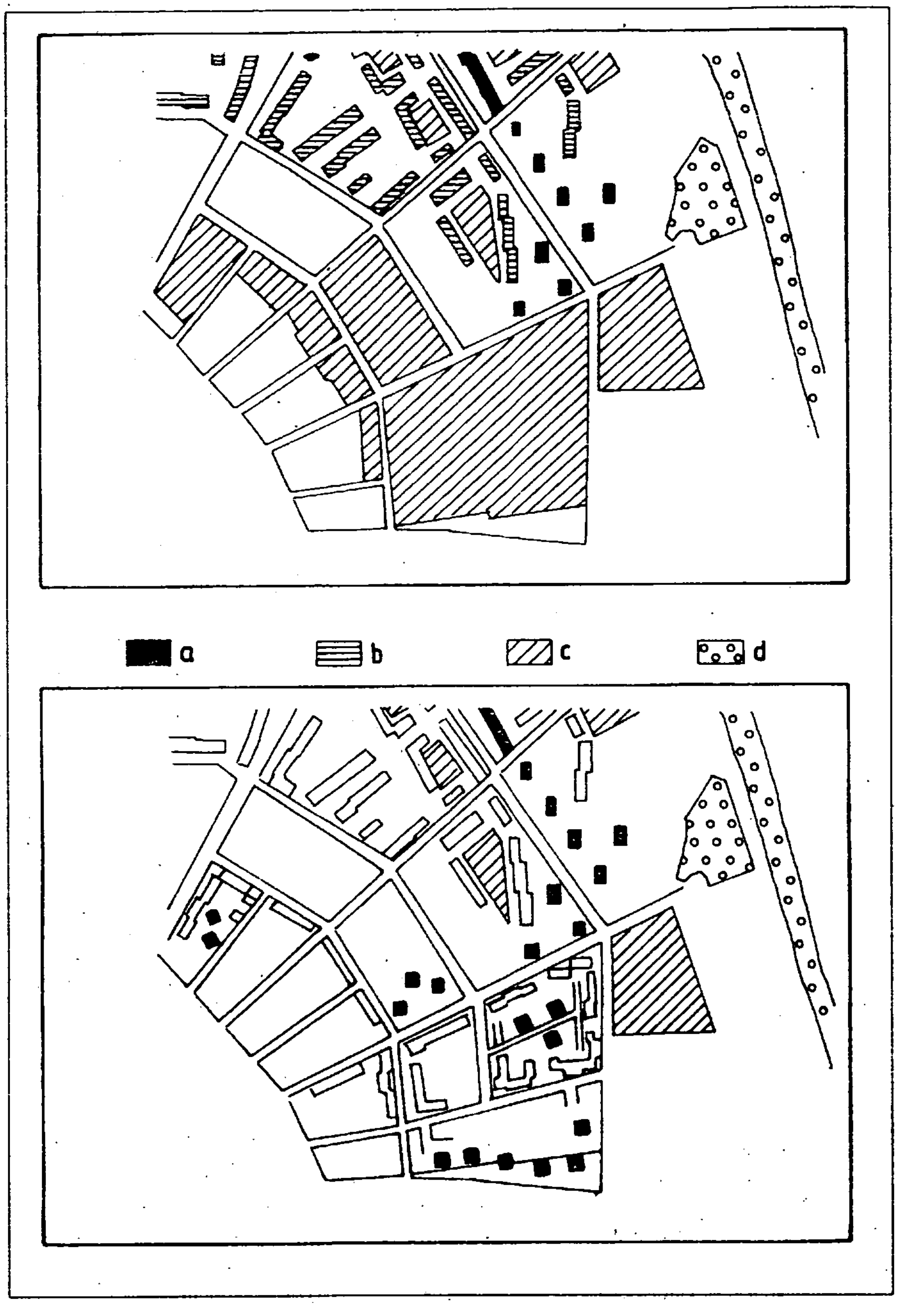


Figure 5. *Topographic map from 1983 and its updated version used by SPOT XS, P images and airphotos a= 8-10 storied houses, b= 4-5 storied houses, c= open field, d= forest*

References

B.C. FORSTER et al: Mapping and urban multi-experimental assessement of SPOT - urban results - SPOT 1987 Conference, Paris pp. 669-674.

D.R. MORRIS-JONES et al: Applications of SPOT data for urban real estate investment information systems - SPOT 1987 Conference, Paris pp. 661-667.

N.A. QUARMBY et al: Monitoring urban land cover changes at the urban fringe from SPOT HRV in South-East England - SPOT 1987 Conference, Paris pp. 575-581.

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ASSESSMENT OF WIND EROSION RISK ON THE AGRICULTURAL AREA OF SOUTHERN PART OF HUNGARY

József Szatmári

Introduction

Wind erosion poses a serious problem in many parts of the world and is a dominant issue in Hungary too, where there are wind-blown areas of a considerable size. These occupy nearly 23 per cent of the total surface of the country. Agricultural land, which is most susceptible to wind erosion is situated in a large blown-sand area in the southern part of Hungary, between the Danube and Tisza rivers (Fig. 1.). Wind-blown sand areas play a considerable part in farming and their importance is ever growing. Thus conservation of light sand soils against wind erosion is apparently vital, so much the more as the privatization started in the first years of this decade brought fundamental changes in facilities of soil protection. In the collectivization period a country–wide soil protection network directed and supervised the research to reduce the damages caused by wind erosion, and the field and laboratory experiments and measurements. However, due to the radical reduction of the network (STEFANOVITS, P. 1996), it is more and more difficult to provide concerned private landowners with suitable information and advice.

Arrangements

The Department of Physical Geography launched a research project on wind erosion in 1994. To study deflation occurring in the Danube-Tisza Interfluve, a research station was located for measurements of deflation and accumulation of sandy soils, of meteorological and climatic conditions of wind erosion (Fig. 2.).

Experimental parcel was located next to the former hydro meteorological station of VITUKI (Research Institute for Water Resources Development) following the concept of KARÁCSONY, J. The main reason of our choice of this territory was that there has been hydrological research since 1962 in the catchment area of Fehértó–Majsa Main Canal, which provides us continuous hydrological, pedological and meteorological series of data on the area. Beside the traditional research methods, most up–to–date methods should also be applied, which enables us to gain information from isolated field data measured on relatively small territories to bigger regions. The specific structure of pedological, land use and water balance features defines the rate of extrapolation. To estimate this rate we suggest using Remote Sensing and GIS methods.

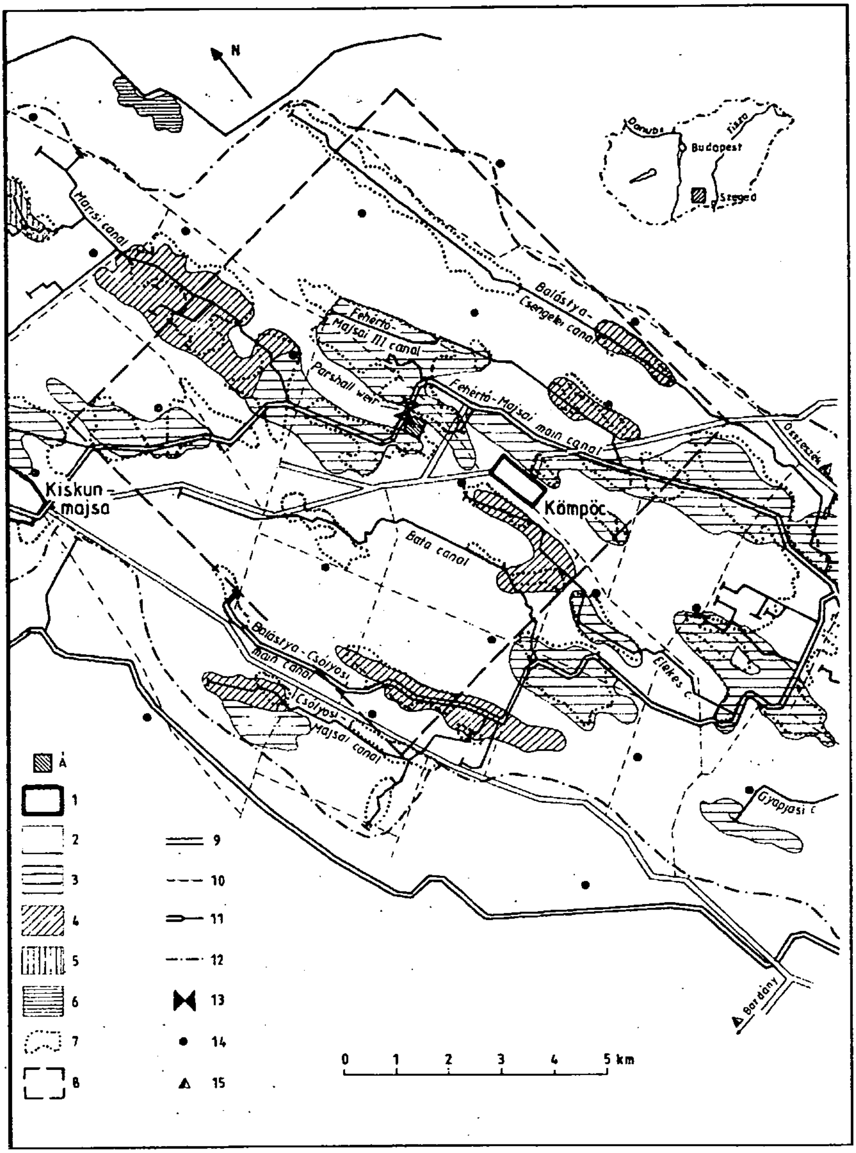

Figure 1. *Fehértó-Majsa Experimental Catchment Á:research station, 1:village; 2:sand; 3,4,5:alcaline soil; 6:lake; 7:temporarily flooded area; 8:test area; 9:road; 10:road; 11:canal; 12:watershed divide; 13:weir; 14:groundwater observation well; 15:archaeological excavations*

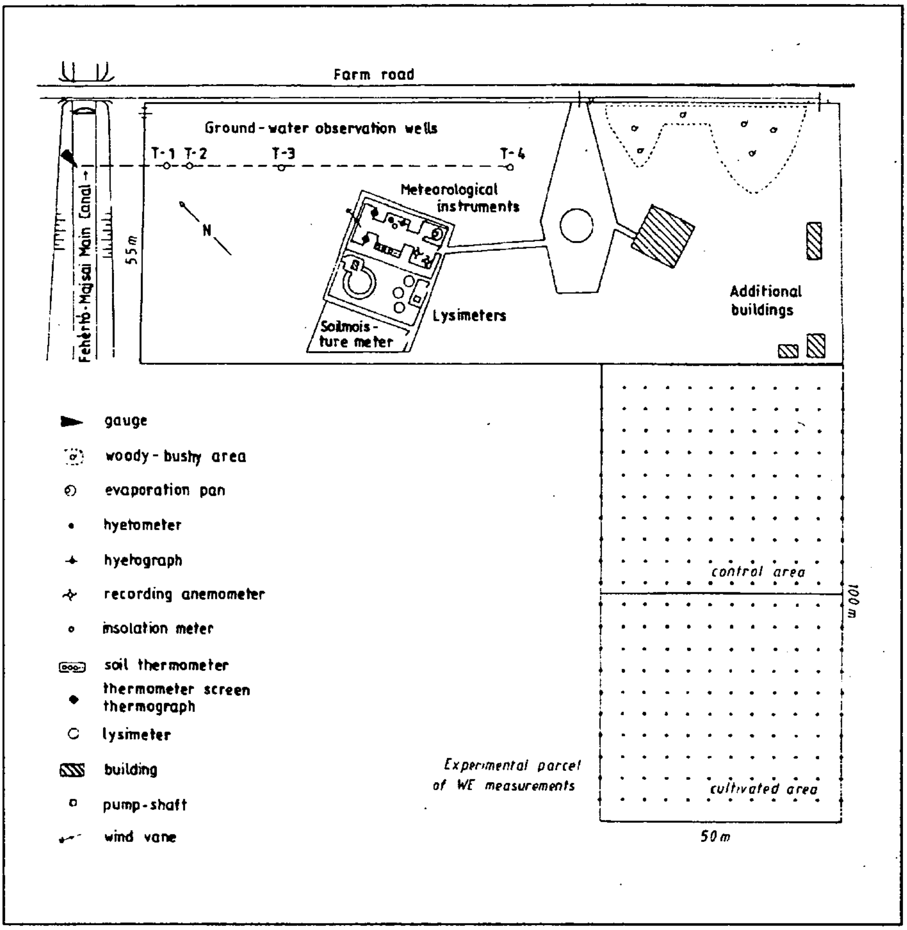

Figure 2. *The hydro meteorological station and the experimental parcel of measurements of wind erosion*

In this detailed study we examine the meteorological aspects of wind erosion and the results of the first year of the research. At the same time the change on land use and theconnection between the land utilization and wind erosion are also investigated on the test area. Remote Sensing is proved to be a possible source of data from which updated land cover information can be obtained effectively (Y. SMARA, et al. 1995). With the help of satellite images we can investigate the most important reasons of wind erosion, e.g., surface temperature, condition of vegetation and soil moisture. By using aerial photos larger accumulated and eroded resultant forms can be characterized. In order to characterise the surface state better, we must integrate data other than remotely sensed ones, such as measured data derived from the field and laboratory work.

The study area

Geomorphology and lithology

The test site is situated near Kiskunmajsa on the SE part of the Danube-Tisza Interfluve. The wind-blown sand areas can be investigated from the western border of the alluvial flood plain of the river Tisza. This area is the residue of the large alluvial fan of the river Danube, which was mainly formed during the Pleistocene. The sand and sandy silt deposits of the alluvial fan ridge have not been shaped by fluvial since the middle of the Würm (up to the Interpleniglacial epoch). In this period, due to structural motions, the Danube gradually abandoned its alluvial fan in the Interfluve and assumed a N-S direction of flow (BORSY, Z. 1982). Particularly in the Late-Pleistocene and during the dry periods of the Holocene the loose fluvial deposits of the alluvial fan were reworked by wind.

The thickness of the transported and accumulated blown sand ranges from 10 to 30 metres. The most characteristic landforms are windrift, residual ridges, sand hills as well as sand dunes. From the aerial photos the long straight valleys can be studied well, opposed to the accumulated positive sand blown landforms. In these valleys, which are parallel to the most characteristic NW wind direction, there are small lakes or sometimes smaller streams. The valleys with infrequent ponds are not only parallel with the dominant wind direction, but indicate the general slope of the area. The lake basins should be regarded as depressions produced by wind erosion. In addition to deepening by wind erosion the evolution of these depressions is partly the result - in the periods of spring snowmelt and rainy weather - of surface waterflow and ground water percolation (JAKUCS, L. 1990).

The soil of the territory consists predominantly of sand (dominant grain–size is 0,1–0,2 mm) with silt in spots. On the bottom of the valleys, silty-sodic sediments are being formed containing dolomite silt (carbonate content of it reaches 80% at certain places) and clay. The thickness of silty and alkaline soil layers generally does not exceed 0,5–1,0 metres (Fig. 3.).

Environmental degradation caused by man

Lack of palaeosol soil prevents us having precise chronological data on sand movements in the Holocene. In the warmer and drier periods of the Boreal and Atlantic phases there may have been significant periods of sand movements (BORSY, Z. 1982). After the Atlantic phase due to the strengthening of the vegetation, sand movement could have only been caused by anthropogenic activities (LÓKI, J. 1994).

Observing soil profiles of archeological excavations near the study area, we came to the conclusion that the possibilities of accumulation of several-metre-thick wind blown sand on these surfaces have been very little in the latest 2000 years.

The deforestation, which extended to larger and larger areas in the 16th century, completely changed the state of land cover. Wind blown sand covered the surface of the Great Hungarian Plain as thick as 20-300 cm. There were devastating dust storms in the Danube-Tisza Interfluve in 1756-58, which were caused by the destruction of grassland downtrodden and poached by inconsiderate grazing (BODOLAY, I. 1965).

Deforestation in the 18th century was extended to dune surfaces with higher relief energy, in order to conquer newer and newer territories for agriculture (BORSY, Z. 1982). Studying Fig. 4. and Tab. 1. we can follow changes in land use on the area if we compare the appropriate classes of first (1782) and third (1881) military mapping and a topographical map from 1983. At the end of the 18th century primaeval forests partially hindered sand movement. In the following century most of these forests were cut and planted vineyards and orchards in several areas, though vast territories were still exposed to damages caused by wind erosion.

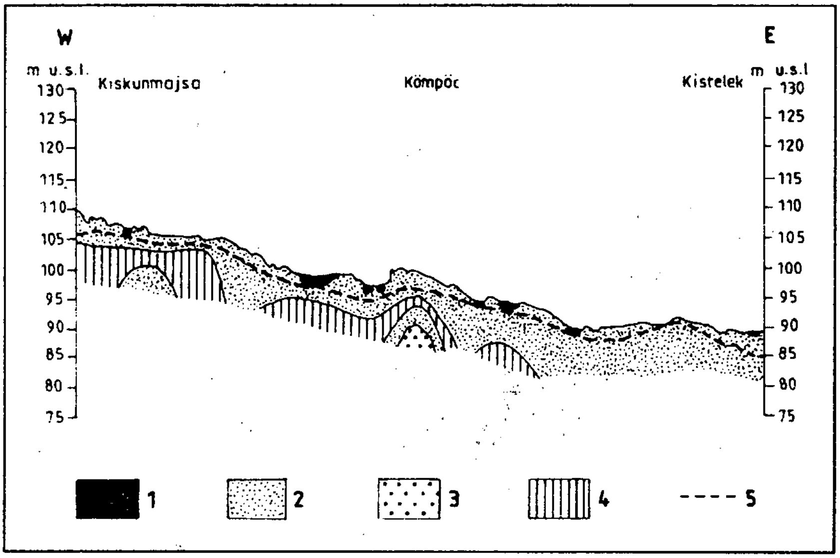

Figure 3. *Geological profile of the test area 1:calcareous mud; 2:wind-blown sand; 3:loessic sand; 4:typical loess; 5:ground-water level (after Kuti, L. 1980)*

Land cover (km^2)	*Year of mapping*		
	1782	*1881*	*1983*
Forest	3.30	1.30	9.67
Vineyard, orchard	0.00	1.70	4.76
Swamp (semlyék)	1.52	7.25	17.04*
Lake	0.04	0.75	0.19

*grassland with swamps

Table 1. *Extension of represented types of land cover*

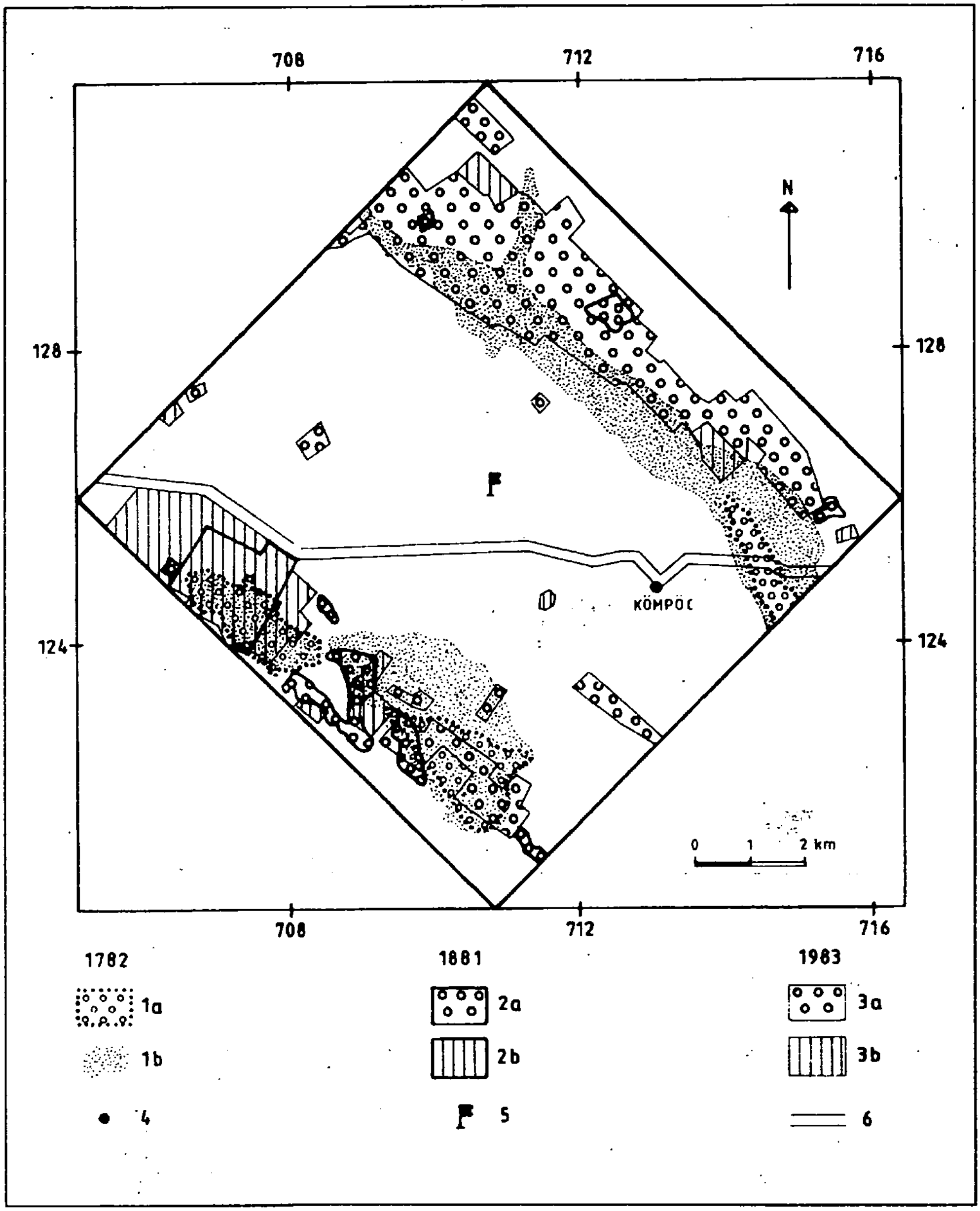

Figure 4.a *Extension of represented types of land cover on different topographic maps between 1782 and 1983 1a-2a-3a:forest; 2b-3b:vineyard, orchard; 4:village; 5:station; 6:road*

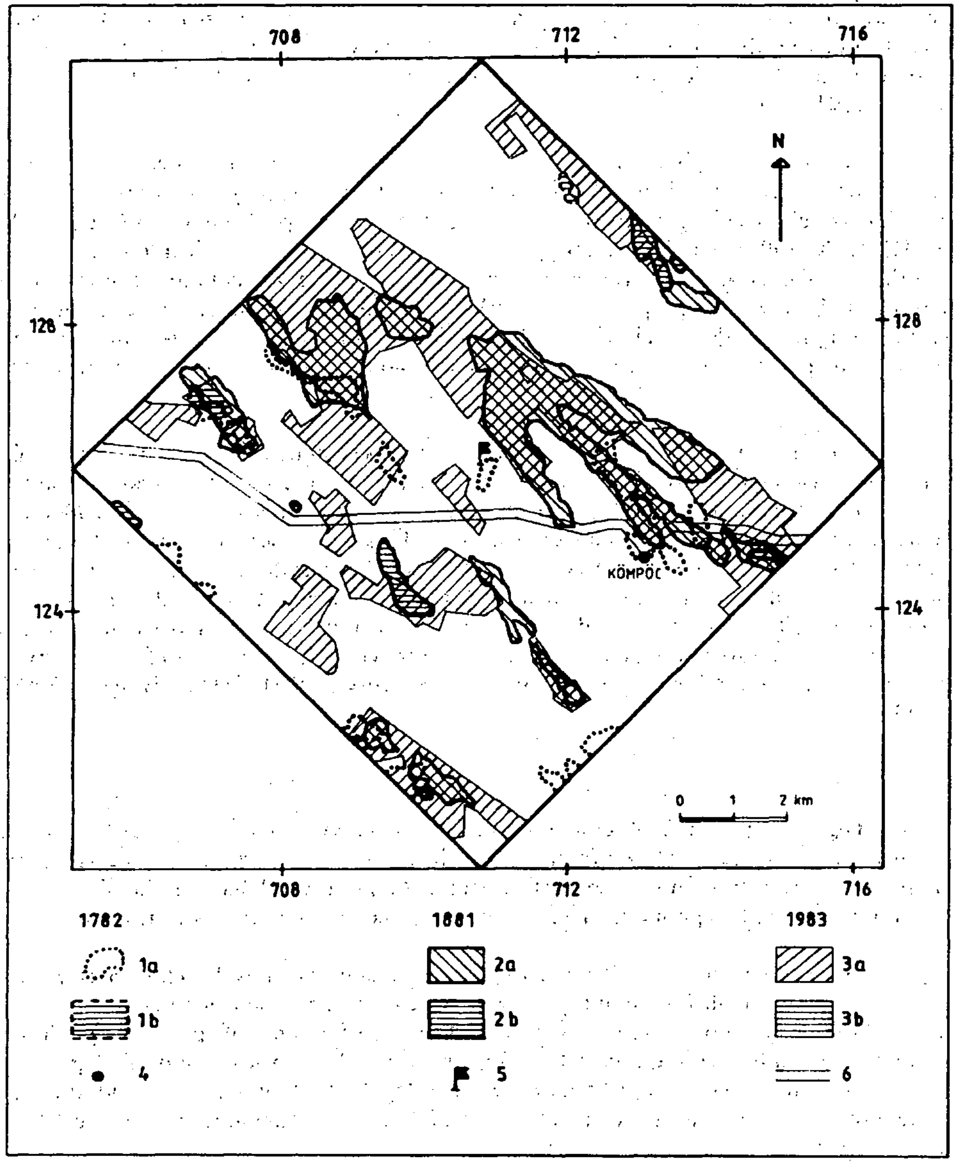

Figure 4.b *Extension of represented types of land cover on different topographic maps between 1782 and 1983 1a-2a:temporarily flooded depression; 3a:grassland; 1b-2b-3b:lake; 4:village; 5:station; 6:road*

Today the NE part of the test area (Kömpöci-erdő) and the SW part of the test area (Aranyhegyi-szőlők, Csólyosi-erdő) are protected against wind erosion. On the Fig. 4.b. we can study the changing extension of grasslands, temporarily and permanently flooded areas. Comparing these map information with the weather conditions of the period and its meteorological data series we can get a more precise picture of the landscape change (SZATMÁRI, J. 1996).

The most attractive interferences within the agricultural landscape, however, were those of the modern times in which the territories most threatened by wind erosion were the most intensively used agricultural lands with the highest production (HRADEK, M.; SVEHLIK, R. 1995). The largest intervention within the structure of farm plots, however, was that of the collectivization period which features the agriculture of this country between 1960-1989. The spreading of plant cultivation technologies necessitated the creation of larger fields, which increased the length of affected areas. Large areas of fields on which there was no vegetation in repeated seasons have been now exposed to wind erosion.

The structure of land use in the early 1960s with much smaller fields and with a dense *tanya* (grange) network and rows of trees (shelter belts) approached the optimal organization of plough-fields. We compared the topographic maps (scale of 1:100000) of the test area mapped before the collectivization and mapped much later, in the 1980s. The number of granges on this area was 160 at the end of the 19th century, 340 in the early 1960s whereas this number is nowadays 190. The disappearance of the granges was accompanied with a significantly decreasing length of rows of trees and shelter-belts. A way to improve the spatial organization, which is unfavourable today, is to form a complex shelter-belt system in all the areas sensitive to wind erosion (BAUKÓ, T.; BEREGSZÁSZI P. 1990).

Climate

The average annual precipitation for this area is lower than 550 mm. The average monthly and annual precipitation figures show the presence of a dry period in early spring, middle summer, late summer and early autumn. In the second half of the summer the probability of a rainless period is much higher here than in other regions of Hungary.

The investigated area has a continental climate and may be characterized as a warm sand steppe with hot summers. In warm years mean annual temperature is above 11.5°C. July mean temperature is above 22°C. The largest number of summer days (85-90) is found here and hot days are more than 30 annually. A long, warm autumn is typical; the daily temperature sinks below 10°C after October 25. Winter is moderately cold, the mean temperature for January is -1.5°C. In spring the daily mean temperature rises above 10°C as early as April 5.

The potential and actual evapotranspiration show a considerable water deficit in the area from May (10 mm) to September (in August 48.8 mm). Consequently, the soil surface totally dries up during this period, the grains of the upper sandy soil lose their water content which is necessary for bonding. In this way, wind erosion can remove, blow out, transfer and accumulate sand (MUCSI, L. 1993).

The prevailing wind is the NW, while the second most frequent direction is the SE, with higher frequencies in the spring and autumn months (TAR, K. 1991). The strong NW and NNW (above 5°B) winds are most frequent between June and September (JAKUCS, L. 1990).

Based on the data series of measurement between 1963 and 1973 (source: KIENITZ, G. 1974) the weekly frequencies of winds higher than 3 m/s (daily averages) and the averages of dry soil state (BODOLAY, I. 1965) were compared. The values clearly indicate that the months of April, October and November are critical from the aspect of wind erosion (Fig. 5.).

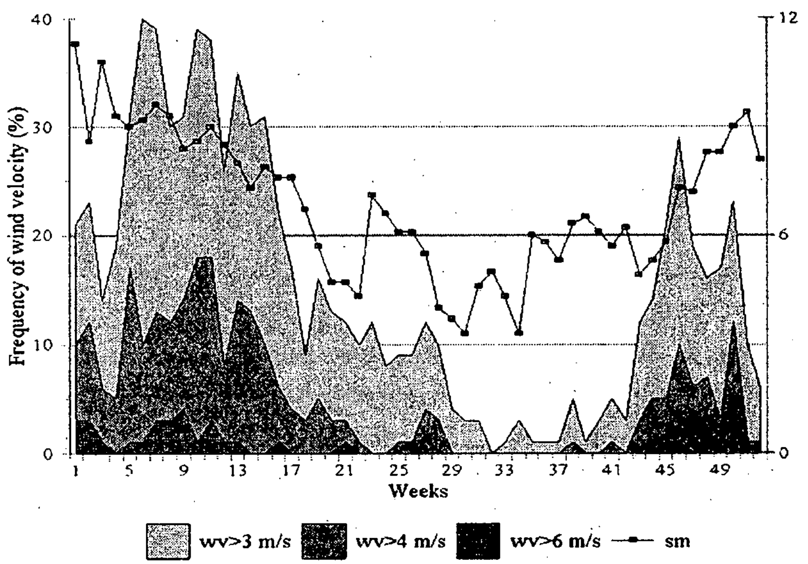

Figure 5. *Weekly frequencies of wind velocity (wv) and the averages of dry soil state (soil-moisture=sm<6%) between 1963-1973*

Comparing relationships between the frequency of different wind velocity with the frequency of values of soil moisture the correlation coefficients show significant relationship between the winds which are stronger than 3-4 m/s with the dry soil state (0.6-0.7). There was a weaker correlation (0.4) in the case of weekly frequencies of winds with higher than 6m/s velocity, suggesting that the strongest occurrences of wind (February-April, November) do not coincide with the driest periods of soil state in the area (July-August).

The climatological prognostics suggest 1 mm annual precipitation loss for the next decades and the predicted rise in temperature is 0.5°C in twenty years and 1.0°C rise in fifty years in the Danube-Tisza Interfluve. All these mean that the annual rainfall will drop below 500 mm and that will not cover the water demand of the region. They result in a growing aridification and in dropping of the ground water table, which is to mobilize the sand movement in the region. Due to the changing climatic conditions 30-50 percent increase of the wind erosion rate may be predicted (MEZŐSI, G. 1996).

Methods

The purpose of our research is to work out the wind erosion model of the Danube-Tisza Interfluve: to mark the territories endangered by wind erosion and to define the size of these areas and the mass of sandy soils removed by the wind. Between 1995-1998 we have been drawing up and testing the methods of wind erosion monitoring on the test area at Kömpöc.

We started this job by having a parcel formed out next to the Hydro-meteorological station at Kömpöc, where we measure the intensity of wind erosion and the quantity of the soil transported by wind. On the 50 metres by 100 metres parcel we set 1-metre-high stakes beside which we weekly measure the eroded and the accumulated quantity of sand. One part of the parcel is agriculturally cultivated where we plant different types of crops each year. The other part is an uncultivated control area where we can measure erosion arisen on strongly erodible soil surface.

Continuous observation was carried out on the parcel between May 31 and November 29, 1995. These data were computerized by Surfer software (Fig. 6.). Fig. 7. shows that within each two-week-long observation interval, sand was accumulated on the parcel except for some shorter deflational periods. Data series of six months makes us assume that this surface is a depositional area of the sediment removed by wind, which supposition must be supported by further sedimentological analysis. At the border of the control and the cultivated areas, a deep, deflational zone was formed which proves that the densely planted wheat has wind driving effect. We have calculated the mass of accumulated and eroded sand on the 2750 m^2 large uncultivated plot. In 1995, the cultivated part of the parcel was sown by wheat and sand movement practically was not learnt here. In the fall of 1995 we planted clover to this area. A storm-wind at the beginning of November, 1995 totally eroded the first sowing so it had to be repeated in spring. Though there was no wind erosion on the parcel partially due to tillage problems.

Next we marked out a 64 km^2 large test area which has the parcel within its centre. The monitoring methods of the test area were elaborated. We prepare the geomorphological, soil and land use maps of this area. These data form the basis of the remote sensing analysis. We collected airborne photos (1964, 08/05/1988, 04/05/1992), LANDSAT TM satellite images (03/08/1985, 29/08/1992) and SPOT image (21/09/1993) of the test area and we are paying attention to obtaining the latest images as well.

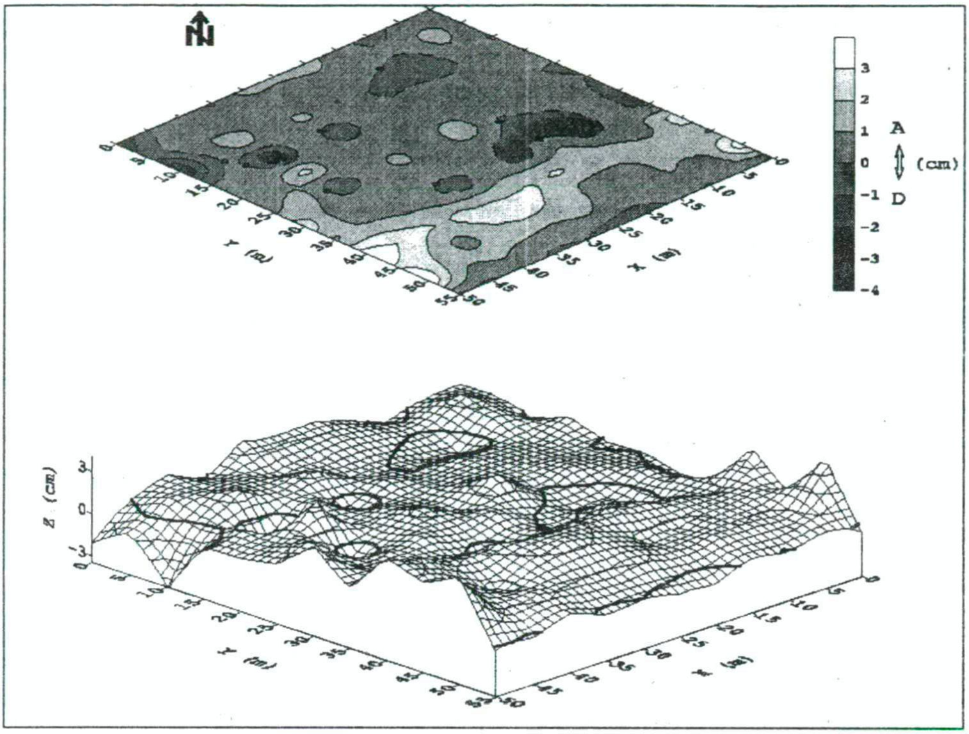

Figure 6. *Contour map and surface of the parcel showing the differences between the initial values and the last measured values in 1995. A=accumulation, D=deflation*

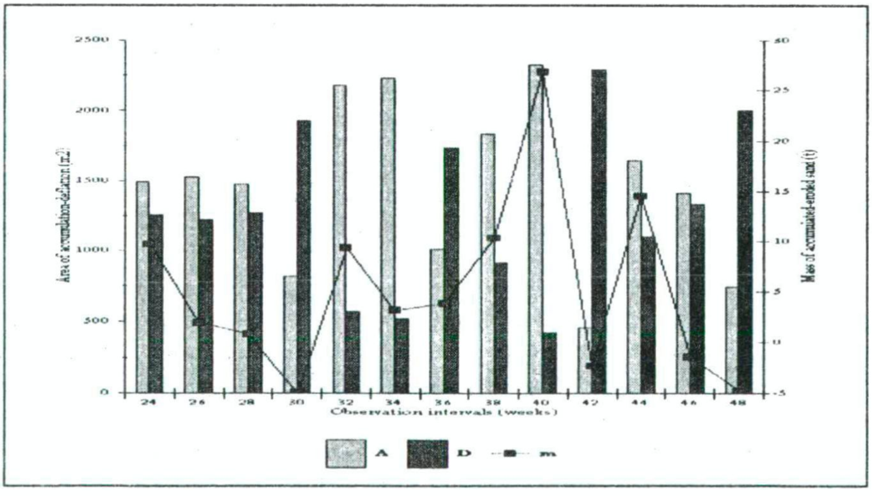

Figure 7. *Area of accumulation (A) and deflation (D) on the experimental parcel (m^2) and mass (m) of the accumulated and eroded soil (ton) between May and November 1995*

We have produced several thematic maps and layers of the test area using ERDAS IMAGINE 8.2 software:

- two photo maps (scale of 1:25000) showing the differences of land use, the spatial structure of farming, wind breaking systems ...etc. of the state of 1964 and 1992 years;
- different real colour and infra red images are used to compare the yearly and seasonal changes;
- airborne photos, satellite images and topographical maps are used to define the different classes of land use maps (Tab. 2.);
- thematic layers based on different indices (VGI, SWI, etc.) and
- soil temperature maps (LANDSAT Band 6).

Year	***Land use (%)***						
	arable	*garden*	*built-up*	*vineyard*	*orchard*	*grassland*	*forest*
1965	64		1	8		24	3
1992	33	14		5	7	24	17

Table 2. *Land use classes in 1965 (on the catchment area of the main canal) and in 1992 (on the test area)*

The introduction of digital images has expanded the techniques of the change detection. According to the NDVI and Vegetation Greenness Index (VGI) which is strongly related to the amount of green vegetation (ERDAS Field Guide 1994)

$$VGI = -0.2848(TM1) - 0.2435(TM2) - 0.5436(TM3) + 0.7243(TM4) + 0.0840(TM5) - 0.1800(TM7),$$

it can be deduced that there are significant and sharp differences in plant cover. The ploughed land and the vineyard are very dry and hot. This can be seen on the pseudo colour image based on the values of Soil Wetness Index (SWI) which relates to canopy and soil moisture:

$$SWI = 0.1509(TM1) + 0.1973(TM2) + 0.3279(TM3) + 0.3406(TM4) - 0.7112(TM5) - 0.4572(TM7).$$

By using the SWI-index image we have classified the driest areas which are exposed to wind erosion to a greater extent. The total size of these areas covers 17.5 km^2 of the 64 km^2 large test site (27%).

On Fig. 8. we signed with the help of remotely sensed data those territories which are endangered by wind erosion. We have also indicated the extension of alkaline soils and the temporarily flooded areas. Comparing Fig. 4. and Fig. 8. we can conclude that remote sensing procedure showed that those agricultural lands are exposed to erosion which were classified neither as afforested nor as temporarily or permanently flooded areas nor as grassland by topographic and field data. In the orchard-vineyard category there was some overlap as these sand surfaces are dry but are less endangered by wind erosion, and they cannot be separated clearly from ploughed lands because of their scattered vegetation.

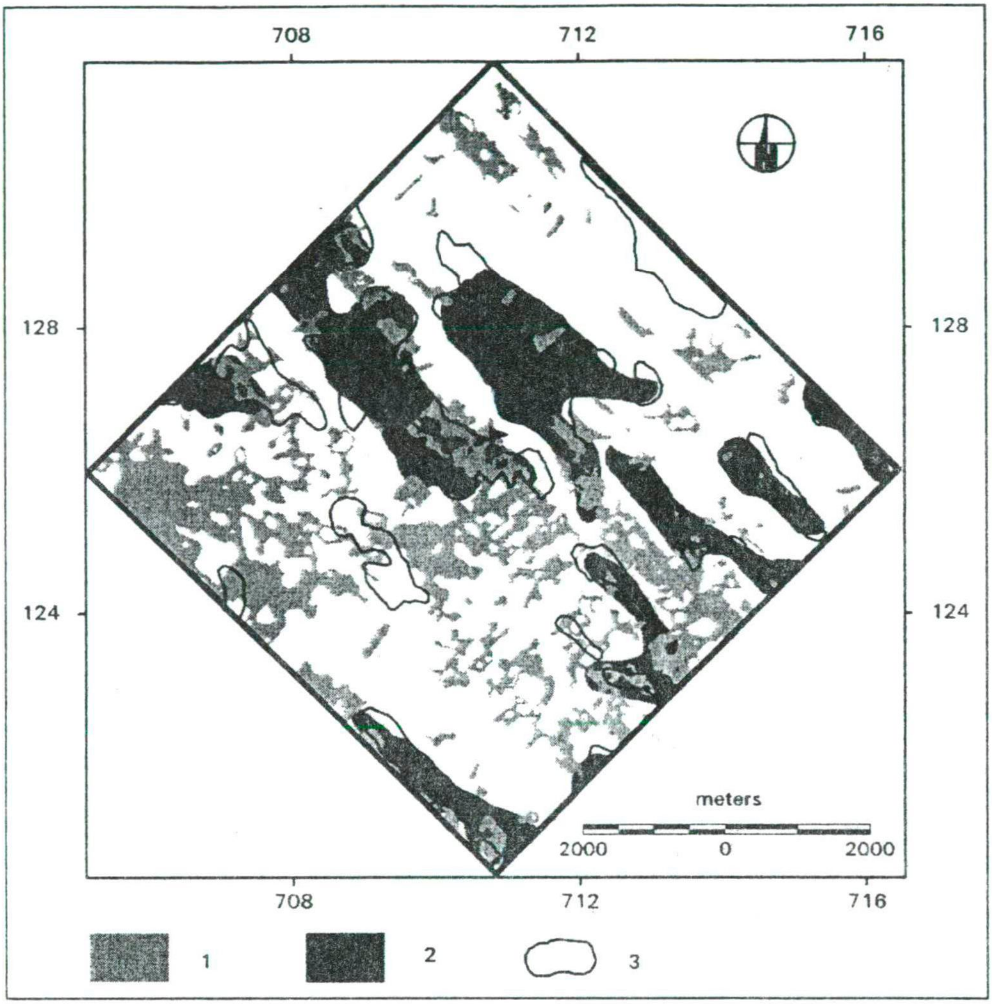

Figure 8. *Map of areas endangered by wind erosion (1; A=17.5 km²) 2:alkaline soil (14.98 km²); 3:temporarily flooded area (12.32 km²)*

Discussion

Research on aridification processes in the Carpathian Basin (KERTÉSZ, Á. 1996; MEZŐSI, G. et al. 1996; MIKA, J. 1993) predicts generally drier conditions in the following decades. Consequently, soil protectionists face increasing work, of which we would like to take our shares. Our long-run aim is to build an observational network on wind erosion in the Danube-Tisza Interfluve. The first steps have already been taken and are summarized below.

- to collect field data of fundamental importance by making measurements on the parcel;
- to mark out large territories which are endangered by wind erosion, using remote sensing which proved to be a reliable means;
- we assume that satisfactory results can be gained from a continuous monitoring of the Danube-Tisza Interfluve based on field experiments, up-to-date remote sensing data and GIS methods. It could be reached only if sciences and their experts concerned cooperated more efficiently than today.

References

BAUKÓ, T.; BEREGSZÁSZI, P. 1990. Simplifying agricultural patterns – Increasing damage by wind in Békés county. Környezetgazdálkodási évkönyv, pp. 87-95

BODOLAY, I.né 1965. Szélerózió elleni védekezés öntözött homokterületeken (Protection from wind erosion in irrigated sand areas). Agrokémia és talajtan. 14. 1-2. pp. 1-15

BORSY, Z. et al. 1982. Phases of blown-sand movement in the North-East part of the Great Hungarian Plain. Acta Geographica Debrecina. XX. pp. 35-50

HRADEK, M.; SVEHLÍK, R. 1995. Dust storms in Moravia and Silesia. In: Natural hazards in the Czech Republic, Brno, pp. 81-109

JAKUCS, L. 1990. Physico-geographical and climatological landscape analysis in the sand areas of Csongrád county with special regard to prevention of wind erosion. Acta Geographica Szegediensis. XXVIII-XXX. pp. 3-30

KERTÉSZ, Á. 1996. Az aridifikáció fogalmának értelmezése. Földrajzi Értesítő XLV. 1-2. pp. 5-9

LÓKI, J. 1994. Mezőgazdaság-központú természetföldrajzi vizsgálatok a Duna-Tisza köze É-i felének példáján. Kandidátusi értekezés. Debrecen. p. 199

MEZŐSI, G. 1996. The predicted wind erosion rate in the Carpathian Basin. Abs. of the IAG ERC'96, Budapest, p. 86

MEZŐSI, G. - KEVEI, F.né - GÉCZI, R. 1996. A Duna-Tisza köz néhány táji értékének prognosztizálható változása. in: Szabó L. (ed.): A termőföld védelme. Gödöllő. pp. 34-48.

MIKA, J. 1993. Az Alföld éghajlatának megváltozása a globális klímaváltozás összefüggésében (Climatic changes in the Alföld in relation to global climatic change). Alföldi Tanulmányok, Békéscsaba XV. pp. 11-31

KIENITZ, G. (ed.) 1974. Data of representative and experimental basins. I. Fehértó-Majsa experimental catchment. Budapest. pp. 105-472

MUCSI, L. 1993. Soil erosion and sand movement in the Southern part of Hungary. In: Proc. of EARSeL'93 Conf. Dundee. pp. 189-200

SMARA, Y. et al., 1995. Methodology for degradation monitoring in an arid and semi arid region. In: Proc. of EARSeL'95 Conf., Czech Rep., pp. 30-39

STEFANOVITS, P. 1996. A talajvédelmi szemlélet globális és regionális módosulása. in: Szabó L. (szerk.): A termőföld védelme. Gödöllő. pp. 3-12.

SZATMÁRI, J. 1996. A természeti táj ember általi átalakításának hatása a szélerózió dinamikájára Duna-Tisza közi mintaterületen. In: Geográfus doktoranduszok első országos konferenciájának előadásai. Pécs.

TAR, K. 1991. Magyarország szélklímájának komplex statisztikai elemzése (A complex statistical analysis of wind climatology in Hungary). OMSZ kisebb kiadványai. 67. pp. 28-88

Geologic map of the Great Hugarian Plain scale of 1:100.000, ed.: KUTI, L. 1980.

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